



REVIEW OF THE *BUFO CRUCIFER* SPECIES GROUP, WITH DESCRIPTIONS OF TWO NEW RELATED SPECIES (AMPHIBIA, ANURA, BUFONIDAE) ¹

(With 27 figures)

FLAVIO A. BALDISSERA JÚNIOR ^{2,3}

ULISSES CARAMASCHI ^{4,5}

CÉLIO F. B. HADDAD ^{3,5}

ABSTRACT: The *Bufo crucifer* species group is revised on the basis of external morphological and morphometrical characteristics, evidencing variation in size, shape of the parotoid gland, width of the head, cranial crests, and presence or absence of yellow spots near the cloaca and hind limbs. Five species are recognized: *B. crucifer* Wied-Neuwied, 1821, *B. ornatus* Spix, 1824 (revalidated), *B. henseli* A.Lutz, 1934 (revalidated), *B. abei* sp.nov., and *B. pombali* sp.nov. The geographic distribution of the species is associated with the Atlantic Rain Forest and adjacent areas: *B. crucifer* occurs from the State of Ceará to southern State of Espírito Santo and northeastern State of Minas Gerais; *B. ornatus* is distributed from southern State of Espírito Santo, through the states of Rio de Janeiro and São Paulo to northern State of Paraná, and possibly in northeastern Argentina, in the provinces Misiones and Corrientes; *B. henseli* is found from southern State of Santa Catarina to the coast of the State of Rio Grande do Sul; *B. abei* sp.nov., described from Córrego Grande, Municipality of Florianópolis, State of Santa Catarina, is distributed from the State of Paraná to southern State of Santa Catarina and areas of the northern State of Rio Grande do Sul; and *B. pombali* sp.nov., described from the Reserva Biológica de Peti, Municipality of São Gonçalo do Rio Abaixo, State of Minas Gerais, occurs in transitional areas between the Atlantic Rain Forest and the "cerrados" in the State of Minas Gerais. Additionally, *Bufo crucifer* var. *pfrimeri* Miranda-Ribeiro, 1926, currently in the synonymy of *B. crucifer*, is transferred to the synonymy of *Bufo guttatus* Schneider, 1799. *Bufo levicristatus* Boettger, 1885 is considered a *species inquirenda* and removed from the synonymy of any species included in the *B. crucifer* group. *Bufo spixii* Fitzinger, 1826 is transferred from the synonymy of *Bufo margaritifera* (Laurenti, 1768) to the synonymy of *Bufo ornatus* Spix, 1824.

Key words: *Bufo crucifer*, *B. ornatus*, *B. henseli*, *B. abei* sp.nov., *B. pombali* sp.nov., Morphometrics, Taxonomy.

RESUMO: Revisão das espécies do grupo de *Bufo crucifer*, com descrições de duas espécies relacionadas (Amphibia, Anura, Bufonidae).

O grupo de *Bufo crucifer* é revisado com base em caracteres morfológicos externos e morfométricos, evidenciando variação em tamanho, forma das glândulas parotóides, largura da cabeça, cristas cefálicas e presença ou ausência de manchas amarelas próximo à cloaca e nas pernas. Cinco espécies são reconhecidas: *Bufo crucifer* Wied-Neuwied, 1821, *B. ornatus* Spix, 1824 (revalidada), *B. henseli* A.Lutz, 1924 (revalidada), *B. abei* sp.nov. e *B. pombali* sp.nov. A distribuição geográfica das espécies é associada à Floresta Atlântica e regiões adjacentes: *B. crucifer* ocorre do Estado do Ceará ao sul do Estado do Espírito Santo e nordeste do Estado de Minas Gerais; *B. ornatus* ocorre do sul do Estado do Espírito Santo, através dos Estados do Rio de Janeiro e São Paulo até o norte do Estado do Paraná e possivelmente no nordeste da Argentina, nas Províncias Misiones e Corrientes; *B. henseli* é encontrada do sul do Estado de Santa Catarina até a região costeira do Estado do Rio Grande do Sul; *B. abei* sp.nov., descrita de Córrego Grande, Município de Florianópolis, Estado de Santa Catarina, está distribuída do Estado do Paraná até o sul do Estado de Santa Catarina e áreas do norte do Estado do Rio Grande do Sul; *B. pombali* sp.nov., descrita da Reserva Biológica de Peti, Município de São Gonçalo do Rio Abaixo, Estado de Minas Gerais, ocorre nas áreas de transição entre a Floresta Atlântica e os cerrados no Estado de Minas Gerais. Adicionalmente, *Bufo crucifer* var. *pfrimeri* Miranda-Ribeiro, 1926, atualmente incluída na sinonímia de *B. crucifer*, é transferida para a sinonímia de *Bufo guttatus* Schneider, 1799. *Bufo levicristatus* Boettger, 1885 é considerada *species inquirenda* e retirada da sinonímia de qualquer das espécies incluídas no grupo de *B. crucifer*. *Bufo spixii* Fitzinger, 1826 é transferida da sinonímia de *Bufo margaritifera* (Laurenti, 1768) para a sinonímia de *Bufo ornatus* Spix, 1824.

Palavras-chave: *Bufo crucifer*, *B. ornatus*, *B. henseli*, *B. abei* sp.nov., *B. pombali* sp.nov., Morfometria, Taxonomia.

¹ Received on March 18, 2004. Accepted on June 29, 2004.

² Current address: Universidade Católica de Santos (UNISANTOS). Campus Dom Idílio José Soares, Avenida Conselheiro Nébias, 300, Santos, 11015-002, SP, Brasil. E-mail: baldisseri@unisantos.br.

³ Universidade Estadual Paulista, Departamento de Zoologia (IB). Caixa Postal 199, 13506-900, Rio Claro, SP, Brasil.

⁴ Museu Nacional/UFRJ, Departamento de Vertebrados. Quinta da Boa Vista, São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brasil.

⁵ Fellow of Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

INTRODUCTION

The name *Bufo crucifer* Wied-Neuwied, 1821 was originally proposed for populations distributed along the Atlantic Rain Forest and its areas of influence in the State of Bahia, Brazil (BOKERMANN, 1966). According to MARTIN (1972), FROST (1985, 2002), and DUELLMAN & SCHULTE (1992), the *B. crucifer* species group is composed exclusively by the nominal species. This species is ecologically restricted to forested areas (KLOSS, 1972) or, at least, associated with those areas (JIM, 1980). According to HADDAD & SAZIMA (1992), this species group has a wide distribution and there would be probably more than one species under this name. In the recent past, the different forms found throughout this wide distribution area were considered species or subspecies, causing vast synonymy (see A.LUTZ, 1934; COCHRAN, 1955; FROST, 2002). Currently, there are 15 available names for the different morphotypes of the *B. crucifer* species group.

WIED-NEUWIED (1821) described *Bufo crucifer* in the second volume of his book and the specific name was given in reference to the dorsal pattern present in some adult specimens. This pattern resembles a triple cross, the optical effect of which is made by black marks that follow the vertebral line. The usage of this characteristic seems to have contributed to a large taxonomic confusion among the morphotypes of this species group because it has been shown to be extremely polymorphic in adult individuals and is variably present or absent in all known populations of the *B. crucifer* species group (our data).

SPIX (1824) described *Bufo ornatus* using specimens from the Province of Rio de Janeiro (now Municipality of Rio de Janeiro). Two other species, *Bufo dorsalis* and *Bufo scaber*, were described in the same paper using specimens from the same area. These latter are, in fact, polymorphic individuals of the former. The polymorphic color pattern and the large availability of specimens from Rio de Janeiro led to descriptions of several new species, resulting in many synonyms for *B. ornatus*.

Through descriptions and re-descriptions, few useful taxonomic characteristics were detected by different authors. GÜNTHER (1858, p.141) in his *addendum*, stated that some specimens possessed a line of tubercles in the tarsal region (“...cutaneous fold along the inner edge...”). A.Lutz (1934), in his description of *Bufo crucifer* var. *henseli*, used the yellow spots in the legs and the shape of the

parotoid glands as diagnostic characteristics. Additionally, species were described based on specimens of doubtful origin; DUMÉRIL & BIBRON (1841) described *Bufo melanotis* using a series from “Cayenne et au Brésil”; GÜNTHER (1858) worked with specimens from Puerto Cabello, Venezuela and “South America”, which probably were not members of the *B. crucifer* species group. These facts created an inaccurate geographical distribution for the group.

By the end of the 19th century, the confusion of names and species gave rise to a general tendency of synonymizing all known species to the epithet *B. crucifer*. BOULENGER (1882) was the first to synonymize almost all available names to the senior name *B. crucifer*. NIEDEN (1923) re-described *B. crucifer*, synonymizing all other available names to it. Later, COCHRAN (1955), CEI (1980), and DUELLMAN & SCHULTE (1992) accepted the group as monotypic, constituted only by *B. crucifer*. FROST (2002) also considered *B. crucifer* as the only valid species for the group and listed all other available names as its synonyms.

MATERIAL AND METHODS

The methodology was based on HEYER (1984). Several collections were used in order to obtain a considerable number of specimens for the taxonomic and morphometric analyses. The specimens were ordered by their geographic localities, males and females were analyzed separately, and sets were constructed following their morphological similarities. The individuals belonging to the different sets were measured for the morphometric analysis. For the general external characteristics we followed DUELLMAN (1970), CEI (1980), and HEYER *et al.* (1990); for the cranial crests we followed A.Lutz (1934); for the webbing formula notation we followed SAVAGE & HEYER (1967), modified by MYERS & DUELLMAN (1982). The specimens collected were preserved according to methodology described in McDIARMID (1994). For the comparisons among the different species only males were used, unless when indicated in the text.

Specimens used in the descriptions or examined for comparisons are deposited in: AL-MN (Adolpho Lutz collection, housed in the Museu Nacional, Rio de Janeiro, RJ, Brazil); CFBH (Célio F.B. Haddad collection, deposited in the Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, SP, Brazil); CHUNB

(Coleção Herpetológica da Universidade de Brasília, DF, Brazil); EI (Eugenio Izecksohn collection, housed in the Instituto de Biologia Animal, Universidade Federal Rural do Rio de Janeiro, Seropédica, RJ, Brazil); FETA (Fundação de Ensino e Tecnologia de Alfenas, MG, Brazil); JJ (Jorge Jim collection, housed in the Instituto de Biociências, Universidade Estadual Paulista, Botucatu, SP, Brazil); MACN (Museo Argentino de Ciencias Naturales, Corrientes, Argentina); MCN (Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, RS, Brazil); MCP (Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS, Brazil); MNRJ (Museu Nacional, Rio de Janeiro, RJ, Brazil); MZUSP (Museu de Zoologia, Universidade de São Paulo, SP, Brazil); PCAG (Paulo C.A. Garcia field number); SJRP (Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista, São José do Rio Preto, SP, Brazil); ZUEC (Museu de História Natural, Universidade Estadual de Campinas, SP, Brazil); ZUFMS (Departamento de Zoologia, Universidade Federal de Santa Maria, RS, Brazil).

For the morphometric analysis, a total of 53 external morphologic characters were measured in an initial sample of 70 specimens. A multivariate analysis (SOKAL & ROHLF, 1995) was applied to these measurements in order to identify which would be significant for definition of the different species. Twenty-five variables among the 53 original ones were considered statistically useful. Another set of 236 specimens was measured using the 25 significant variables. All measurements were done using a digital caliper Mitutoyo (precision 0.1mm). The 53 characters and respective abbreviations, with the significant ones ($P < 0.05$) indicated by an asterisk (*), are: snout to vent length (SVL*); head length (HL*); head width (HW*); inter-choanae distance (IC*); snout to nostril distance (FN/DNF); inter-nostril distance (IND*); nostril border to upper maxilla distance (NE/ DNM); eye to nostril distance (END*); eye diameter (ED*); upper eyelid length (LL/CP); upper eyelid width (UEW*); interorbital distance (IOD*); eye border to upper maxilla distance (EMD*); canthal ridge length (CRL*); pre-orbital ridge length (CPR/CPRO); post-orbital ridge length (POR/CPOO); orbit-tympanum ridge length (COTI/CCOT); supratympanic ridge length (STR*); parietal ridge length (CPA/CCP); eye to tympanum distance (ETD*); tympanum diameter (TD*);

tympanum height (TH*); inferior tympanum border to upper maxilla distance (TIE/DTM); parotoid gland length (PGL/CGP); parotoid gland width (PGW/LGP); inter-parotoid distance (IPD*); distance between axillae (IA/DA); forearm length (FAR*); upper arm length (UAR*); external carpal tubercle length (ECL/CCCE); external carpal tubercle width (ECW/LCCE); inner carpal tubercle length (ICTL*); inner carpal tubercle width (ICTW*); distance between carpal tubercles (ICC/DCC); hand length (HAL*, measured between the articulation forearm-hand and the base of the third finger); finger I length (FL1/CD1); finger II length (FL2/CD2); finger III length (FL3/CD3); finger IV length (FL4/CD4); armpit-groin distance (AGD*); thigh length (THL*); tibia length (TBL*); tarsal length (TAL*, distance between the articulation of tarsus with tibia and the base of the external metatarsal tubercle); external tarsal tubercle length (ETL/CCTE); external tarsal tubercle width (ETW/LCTE); inner tarsal tubercle length (ITL/CCTI); inner tarsal tubercle width (ITW/LCTI); distance between tarsal tubercles (ITC/DCT); toe I length (TL1/CA1); toe II length (TL2/CA2); toe III length (TL3/CA3); toe IV length (TL4/CA4); toe V length (TL5/CA5).

The canonical analysis was used to test the possible discrimination of the morphologically recognized species, through measurements of their external morphological characters. The eigen vectors and their associated eigen values were obtained from a variance-covariance matrix, and the loadings were the correlations between the original variables and the scores. To determine which variables significantly contributed to each of the canonical axes, Pearson's coefficients correlation (r) was used for each character considered in the analysis of canonical variables. The scores of each individual were projected into the reduced space of those canonical axes, allowing a graphical analysis of the discriminations between the species (CAVALCANTI & LOPES, 1993).

RESULTS

Definition of the *Bufo crucifer* species group

Definition – The genus *Bufo* was briefly defined by LAURENTI (1768), and according to FROST (1985, 2002), *Bufo viridis* Laurenti, 1768 would be the type species for the genus by subsequent designation by FITZINGER (1843). FROST (1985) indicated BLAIR (1972) for the definition of the different

groups of the genus *Bufo*, including the *B. crucifer* species group.

More recently, DUELLMAN & SCHULTE (1992) revised the South American phenetic groups of the genus *Bufo*, presenting a new and better morphological definition for the *B. crucifer* species group. From that definition, we would maintain unaltered three osteological statements: (1) frontoparietals broad, fused with prootics; (2) occipital canal partially roofed; (3) exostosing of dermal roofing bones moderate. The following statements are presented for the first time or modified from DUELLMAN & SCHULTE (1992): (4) presence of a row or group of glandular keratinized tubercles at the corners of mouth; (5) absence of the pre-ocular ridge in the smaller specimens, but always present and strongly elevated in the larger ones; (6) a row of glandular keratinized tubercles following the lateral edges of the body, with the first tubercle united or not to the parotoid gland; (7) parotoid gland varying from moderate to small, triangular, elliptical, or elongate; (8) tympanum always visible, sometimes covered by a tegumentary fold on posterior region; (9) snout varying from truncate to mucronate or sub-elliptical in dorsal view; (10) dorsal integument varying from extremely granular to smooth, giving a velvet aspect, never forming glandular clusters.

Composition – *Bufo crucifer* Wied-Neuwied, 1821; *Bufo ornatus* Spix, 1824 (revalidated); *Bufo henseli* A.Lutz, 1934 (revalidated); *Bufo abei* sp.nov.; *Bufo pombali* sp.nov.

Geographic distribution – The group of *B. crucifer* is distributed throughout the Atlantic Rain Forest Morphoclimatic Domain (*sensu* AB'SÁBER, 1977) and its areas of influence, from the State of Ceará to the State of Rio Grande do Sul, penetrating the states of Minas Gerais and São Paulo, and extending to northeastern Argentina, in the provinces Misiones and Corrientes.

Comparisons – Osteologically, members of the *B. crucifer* species group are closely related to the members of the *B. marinus* species group (see BLAIR, 1972). Species of the *B. crucifer* group have relatively less developed cranial crests, integument comparatively smoother, and smaller parotoid glands when compared to the *B. marinus* species group (DUELLMAN & SCHULTE, 1992). Cytogenetically, species of the *B. crucifer* group present karyotypic features very similar to the species of the *B. marinus* group (BALDISSERA, BATISTIC & HADDAD, 1999).

SPECIES ACCOUNTS

Bufo crucifer Wied-Neuwied, 1821
(Figs.1-5)

Bufo crucifer WIED-NEUWIED, 1821 (type-locality not stated, but see below).

Bufo cinctus SCHINZ, 1822 (type-locality, Espírito Santo, Brazil; restricted by BOKERMANN, 1966).

Bufo stellatus SPIX, 1824 (type-locality, "Provincia Bahiae", Brazil).

Bufo (Oxyrhynchus) semilineatus SPIX, 1824 (type-locality, Rio Itapicurú, Municipality of Queimadas, Bahia, Brazil; restricted by BOKERMANN, 1966).

Bufo (Rhinella) semilineatus – CUVIER, 1829.

Bufo melanotis DUMÉRIL & BIBRON, 1841 (type-locality, "Cayenne et au Brésil"; type-locality discussed by BOKERMANN, 1966).

Ottophys cinctus – FITZINGER, 1860.

Bufo crucifer var. *cincta* – MIRANDA-RIBEIRO, 1926.

Bufo crucifer var. *melanotis* – MIRANDA-RIBEIRO, 1926.

Bufo crucifer var. *stellata* – MIRANDA-RIBEIRO, 1926; A.LUTZ, 1934.

Types – Not designated (WIED-NEUWIED, 1821; FROST, 1985, 2002). According to BOKERMANN (1966), the type-locality would be "between the Piabanha and Issara streams" (approximately 14°58'S, 39°25'W), Municipality of Itabuna, State of Bahia, Brazil. The species is perfectly recognizable and it is unnecessary to designate a neotype.

Diagnosis – (1) The largest species of the group (SVL 56.2-103.9mm in males; 77.9-114.4mm in females); (2) head wider than long, with clear subdivision between head and body in dorsal view; (3) snout rounded to mucronate in dorsal view; (4) thick cranial crests; (5) parotoid glands overhang the lateral edges of body dorsally; (6) first tubercle of the lateral row always connected to the parotoid gland; (7) in life, yellow spots near the cloaca and on posterior surfaces of thighs (in preserved specimens these marks become faint); (8) in preserved specimens, dorsal surfaces of body and limbs uniformly colored, vertebral line generally absent or very thin; (9) a conspicuous fringe on the ventral surface of the tarsus.

Comparison with other species – *Bufo crucifer* differs from the other species of the group by its larger size (mean SVL of *B. crucifer* 81.6mm; *B. ornatus* 63.6mm; *B. henseli* 58.3mm; *B. abei* sp.nov. 65.6mm; *B. pombali* sp.nov. 73.3mm). Additionally, *B. crucifer* differs from *B. ornatus*, *B. henseli*, and *B. abei* sp.nov. in that the parotoid glands overhang the edge of body dorsally (not overhanging in *B.*

ornatus, *B. henseli*, and *B. abei* sp.nov.) and by possessing a fringe on the ventral surface of tarsus (a row of small tubercles in those species). From *B. ornatus* and *B. abei* sp.nov., by possessing, in life, yellow spots near the cloaca and on posterior surface of thighs. From *B. henseli*, by presenting, in dorsal view, a clear subdivision between head and body, and the parotoid gland varying from oval to triangular shape, subdivided and generally enlarged in its anterior portion (narrow, long, and not subdivided in *B. henseli*). From *B. pombali* sp.nov., by the snout short in lateral view (long in *B. pombali* sp.nov.) and vertebral line very thin or absent (always present in *B. pombali* sp.nov., sometimes thick and edged by dark marks).

Description – Descriptive statistics in table 1. A large sized species for the group (SVL 56.2-103.9mm in males; 77.9-114.4mm in females); body robust; dorsal aspect with clear subdivision between head and body; head wider than long (HW/HL=1.13). Parotoid glands varying from elliptical to triangular, generally enlarged on anterior portion, overhanging the lateral edges of body dorsally; first tubercle of the lateral row always connected to the parotoid gland; snout rounded to mucronate in dorsal view, rounded in lateral view; conspicuous cranial crests; roof of head depressed,

forming a concavity with the orbital ridges; pre-orbital ridges elevated; eyes protuberant; width of upper eyelid about 60% of interorbital distance; nostrils protuberant; area between nostrils concave, bordered by the canthal crests; canthus rostralis straight; loreal region concave; choanae circular, large; tongue oval, long, free, enlarged in posterior portion; length of the tongue twice its width; vocal sac single, subgular, moderately developed; a row of keratinized tubercles starting at the corner of mouth and finishing close to the arm insertion; eye-nostril distance about 75% of eye diameter; inter-nostril distance similar to the tympanum diameter; tympanum distinct, medium sized (TD/ED=0.60), generally elliptical when contacting the supratympanic ridge, circular when free. Forelimbs long, forearms moderately more robust than upper arms; hands of moderate size; fingers medium-sized, slightly fringed; webbing absent; relative lengths of fingers IV<II<I<III; inner metacarpal tubercle protuberant, rounded, generally keratinized; external metacarpal tubercle flat, circular to elliptical; subarticular tubercles protuberant, conspicuous. Tibia length greater than thigh length; sum of tibia and thigh lengths about 86% of SVL; toes long; relative lengths of toes I<II<V<III<IV; short interdigital membrane; plantar webbing formula I1-



Fig.1- *Bufo crucifer* Wied-Neuwied, 1821 (MNRJ 21919, adult ♂), dorsal and ventral views.

Table 1. Descriptive statistics of measurements of males of *Bufo crucifer*.

CHARACTERS	AVERAGE	MINIMUM	MAXIMUM	SD
SVL	81.63	56.2	103.9	9.14
HL	27.53	18.6	35.9	3.13
HW	30.98	19.9	42.3	3.91
ICD	6.77	4.2	9.0	0.90
IND	4.21	2.4	6.2	0.92
END	6.08	3.5	9.0	0.91
ED	8.09	4.7	10.1	1.02
UEW	6.35	4.5	8.0	0.65
IOD	11.08	5.6	16.0	1.66
EMD	3.81	1.8	5.8	0.74
CRL	6.01	3.1	9.0	1.22
STR	4.53	2.5	8.0	0.96
ETD	2.97	1.6	5.1	0.84
TD	4.83	2.9	6.5	0.65
TH	5.53	4.0	7.2	0.65
IPD	18.39	11.1	27.0	2.68
FAR	18.86	13.9	25.4	2.07
UAR	26.83	15.0	37.3	3.97
ICTW	3.61	2.7	5.3	0.46
ICTL	2.81	1.7	3.8	0.48
HAL	7.66	5.1	10.9	1.13
AGD	28.99	20.5	37.0	3.86
THL	33.42	25.6	40.5	3.29
TBL	34.72	25.8	45.5	3.65
TAL	20.93	14.9	26.3	2.23

(N=66; SD=standard deviation)

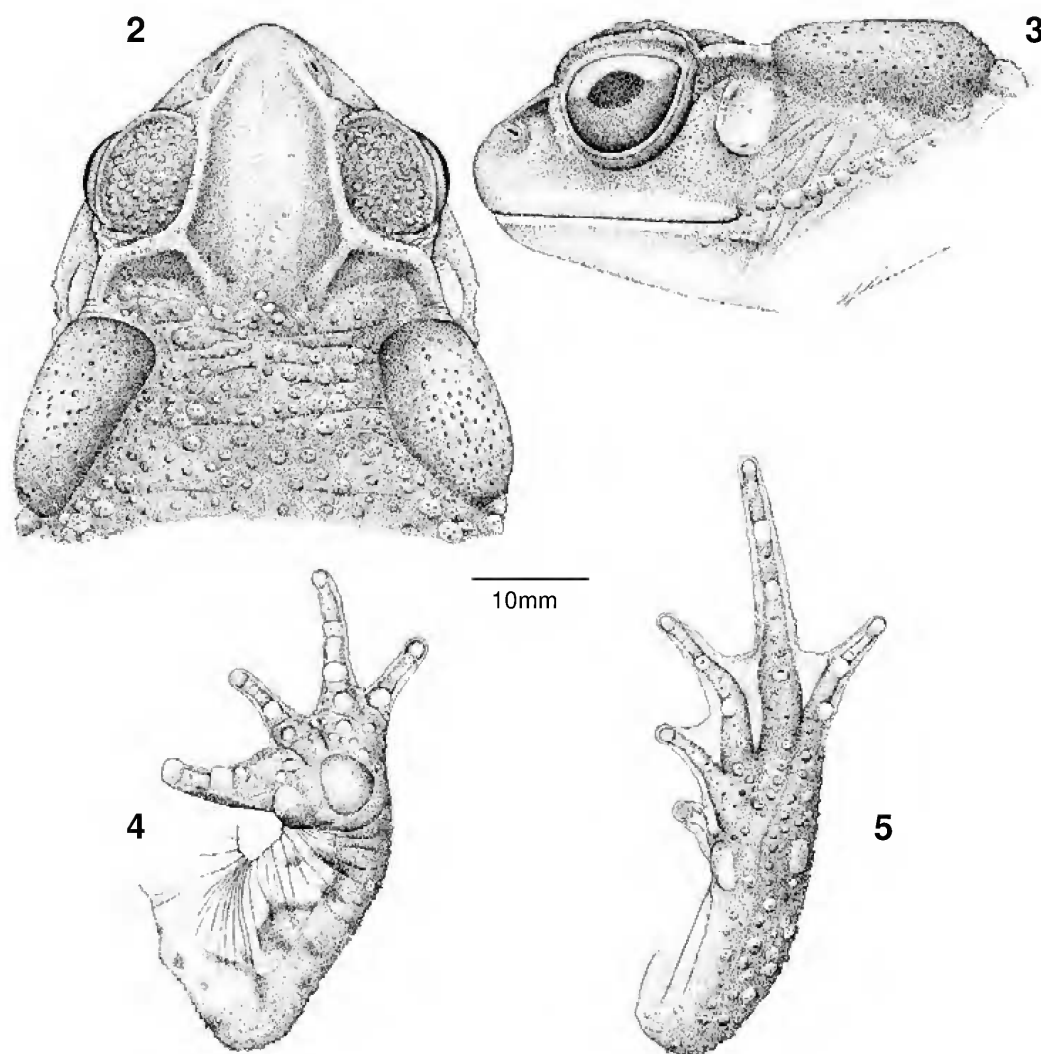
2^{1/2}III1-2III2-3^{2/3}IV3^{2/3}-2V; inner metatarsal tubercle elliptical, protuberant; external metatarsal tubercle circular to elongate; subarticular tubercles small, protuberant; conspicuous fringe along the ventral surface of tarsus, beginning close to the inner metatarsal tubercle and finishing before the tibia-heel articulation.

Color – In life or in preserved specimens, dorsal color uniform, ochre, olive, brownish or silvery; light vertebral line, when present, very thin; in life, ventral area variably colored, from ochre, cream to sprinkled with dark gray marks, which become fainter in the direction of the thighs; yellow marks always present near the cloaca and on posterior surface of thighs.

Geographic distribution – Distributed throughout the Atlantic Rain Forest and adjacent areas, from the State

of Ceará to southern State of Espírito Santo and northeastern State of Minas Gerais, Brazil (Fig.6).

Remarks – *Bufo crucifer* var. *pfrimeri* Miranda-Ribeiro, 1926 (type-locality, “Poço do Rodrigues, Rio da Bagagem, afluente do Rio Maranhão”, State of Goiás, Brazil, according to the original label handwritten by A. Miranda-Ribeiro) is currently referred to the synonymy of *B. crucifer* (see FROST, 2002), although BOKERMANN (1966) had correctly synonymized the former with “*Bufo guttatus* Laurentius, 1768”. The examination of the holotype of *Bufo crucifer* var. *pfrimeri* Miranda-Ribeiro, 1926 (MNRJ 0375) revealed that it is actually a characteristic specimen of *Bufo guttatus* Schneider, 1799. Consequently, *Bufo crucifer* var. *pfrimeri* Miranda-Ribeiro, 1926 is here transferred to the synonymy of *Bufo guttatus* Schneider, 1799.



Bufo crucifer Wied-Neuwied, 1821 (MNRJ 21919, adult ♂): fig.2- dorsal view of head; fig.3- lateral view of head; fig.4- hand; fig.5- foot.

Bufo ornatus Spix, 1824, revalidated
(Figs.7-11)

Bufo ornatus SPIX, 1824 (type-locality, "Provincia Rio de Janeiro", Brasil).

Bufo dorsalis SPIX, 1824 (type-locality, "Provincia Rio de Janeiro", Brasil).

Bufo scaber – SPIX, 1824 (type-locality, "Provincia Rio de Janeiro", Brasil).

Bufo spixii FITZINGER, 1826 (new name for *Bufo scaber* "sensu" Spix, 1824).

Bufo gracilis GIRARD, 1853 (type-locality, "Rio de Janeiro, Brazil").

Phrynoidis ornatus – COPE, 1862.

Rhaebo gracilis – COPE, 1862.

Bufo lentiginosus dorsalis – GARMAN, 1884.

Bufo crucifer var. *roseana* MIRANDA-RIBEIRO, 1926 (type-locality, Rio d'Ouro, Municipality of Nova

Iguaçu, Rio de Janeiro, Brazil; BOKERMANN, 1966).

Bufo crucifer inornatus A.LUTZ, 1934 (type-locality, Rio de Janeiro, Brazil).

Bufo crucifer mayi MIRANDA-RIBEIRO, 1937 (type-locality, Gávea, Rio de Janeiro, Brazil).

Types – SPIX (1824) referred two examined specimens, but HOOGMOED & GRUBER (1983) considered three specimens as original syntypes of *B. ornatus*, two currently being in the Zoologische Staatssammlung München (ZSMH 2691/0) and one in the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH 2157). HOOGMOED & GRUBER (1983) designated ZSMH 2691/0 A as lectotype of *B. ornatus*, and the specimens ZSMH 2691 B and RMNH 2157 as paralectotypes. The type-locality is the Municipality of Rio de Janeiro (22°54'S, 43°12'W), State of Rio de Janeiro, Brazil.

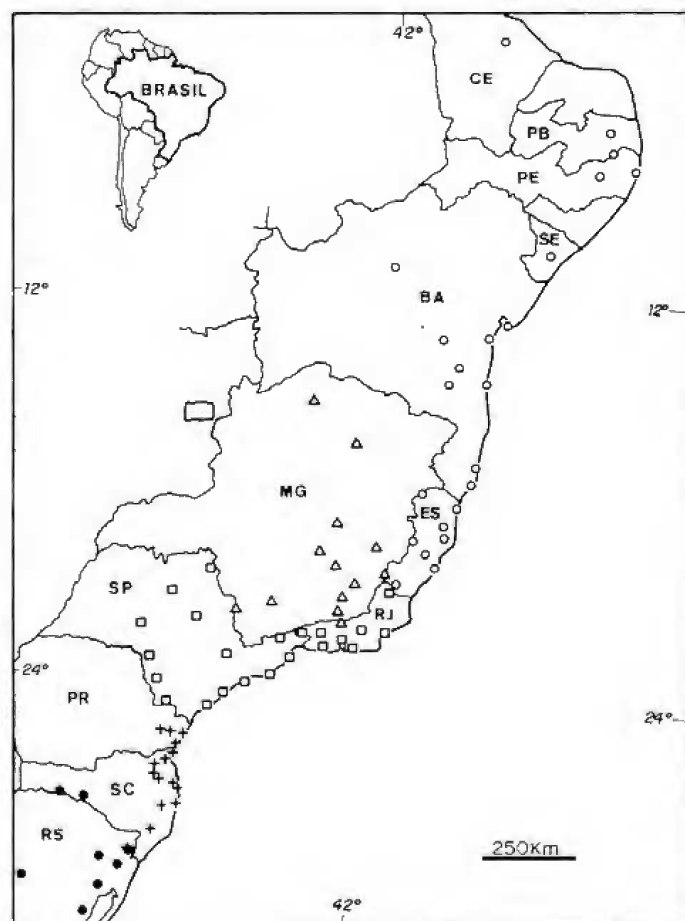


Fig.6- Geographic distribution of the species of the *Bufo crucifer* group. Not all samples examined are represented in the map. The map shows the outermost points of distribution for each species. (O) *B. crucifer*; (Δ) *B. pombali* sp.nov.; (□) *B. ornatus*; (+) *B. abei* sp.nov.; (●) *B. henseli*.

Diagnosis – (1) A medium sized species for the group (SVL 54.5-74.9mm in males; 69.8-88.1mm in females); (2) head wider than long, with clear subdivision between head and body in dorsal view; (3) snout sub-elliptical to rounded in dorsal view; (4) moderate cranial crests; (5) parotoid glands not overhanging the lateral edges of body dorsally; (6) first tubercle of the lateral row always connected to the parotoid gland; (7) absence of yellow marks near the cloaca and on posterior surface of thighs; (8) marks or transverse bands of dark pigmentation on the limbs, mainly on the forelimbs; vertebral line always present; (9) row of small tubercles on ventral surface of tarsus, never forming a fringe.

Comparison with other species – *Bufo ornatus* differs from *B. henseli* by its larger size (average SVL in *B. ornatus* 63.6mm; of *B. henseli* 58.3mm)

and more robust build; yellow marks near the cloaca and on posterior surface of thighs absent (present in *B. henseli*); parotoid glands usually elliptical and enlarged in its anterior portion (narrow and long in *B. henseli*); moderate cranial crests and presence of a row of tubercles on the ventral surface of tarsus (weak cranial crests and minuscule tubercles on the ventral surface of tarsus in *B. henseli*, sometimes forming a line of tubercles). Differs from *B. abei* sp.nov. by presenting general darker color when preserved; sub-ocular band usually hazy (usually conspicuous and lighter in *B. abei* sp.nov.); clear subdivision between head and body in dorsal view, the head wider than of *B. abei* sp.nov.; thicker fingers and toes; shorter forearms with larger diameter than arms (equivalent diameters in *B. abei* sp.nov.). Differs from *B. pombali* sp.nov. by the smaller size (average SVL in *B. pombali* sp.nov. 73.3mm) and less robust build; snout sub-elliptical to rounded in dorsal view (rounded in *B. pombali* sp.nov.); yellow marks near the cloaca and on posterior surface of thighs absent (present in *B. pombali* sp.nov.); a row of small tubercles on the ventral surface of tarsus (a fringe in *B. pombali* sp.nov.). For comparisons with *B. crucifer*, see the previous account.

Description – Descriptive statistics in table 2. A medium sized species for the group (SVL 54.5-74.9mm in males; 69.8-88.1mm in females); body robust; clear subdivision between head and body in dorsal view (SVL/HW=2.79); head wider than long (HW/HL=1.09); parotoid glands generally oval, not subdivided, wider on anterior portion, not exceeding the lateral edges of body dorsally; first tubercle of the lateral row always connected to the parotoid gland; snout sub-elliptical to rounded in dorsal view, sub-acute in lateral view; moderate cranial crests; roof of head depressed, forming a concavity with the orbital ridges; moderate pre-orbital ridges; eyes protuberant; width of upper eyelid about 65% of interorbital distance; nostrils protuberant; area between nostrils flat, bordered by the canthal crests; canthus rostralis straight; loreal region concave; choanae circular, large; tongue oval, long, free, wider in posterior portion; tongue length twice the width; vocal sac single, subgular, moderately developed; a row of keratinized tubercles starting at the corner of mouth and

finishing close to the arm insertion; eye-nostril distance about 73% of eye diameter; inter-nostril distance similar to tympanum diameter; tympanum distinct, medium sized ($TD/ED=0.61$), generally elliptical when associated with the supratympanic ridge, circular when free. Forelimbs long, forearms more robust than upper arms; hands large; fingers long, slightly fringed; webbing absent; relative lengths of fingers $II \approx IV < I < III$; inner metacarpal tubercle elliptical, slightly elevated, generally keratinized; external metacarpal tubercle flat, triangular, circular or elliptical; subarticular tubercles rounded, conspicuous, elevated. Tibia length greater than thigh length; sum of tibia and thigh lengths about 86% of SVL; toes long; relative lengths of toes $I < II < V < III < IV$; short interdigital membrane; plantar webbing formula $I1-2III1^{1/2}-3III2^{1/2}-4IV4-2V$; inner metatarsal tubercle elevated, elliptical; external metatarsal tubercle rounded; subarticular tubercles small, elevated; a row of small tubercles along the ventral surface of tarsus, starting close to the inner metatarsal tubercle and finishing before the tibia-heel articulation, never forming a fringe.

Color – In life, dorsal color uniform, varying from ochre, olive to dark brown; a very thin or thick light vertebral line always present, starting at the rostral area and finishing at the urostile; when thick, it is bordered by approximately symmetrical dark marks from a dark brown to sepia or black; ventral area with variable color, from ochre, cream to sprinkles of gray marks, which become fainter in direction of thighs. In preserved specimens, sub-ocular band, generally light colored, can be hazy, sometimes forming a triangle; dorsal color uniformly dark olive or dark beige; markings and vertebral line become faint; in some males, the subgular vocal sac can be of darker gray color than the rest of the abdomen.

Geographic distribution – Distributed throughout the Atlantic Rain Forest, from southern State of Espírito Santo, through the states of Rio de Janeiro and São Paulo to northern State of Paraná, Brazil (Fig.6), and possibly in northeastern Argentina, in the provinces Misiones and Corrientes.

Remarks – *Bufo spixii* Fitzinger, 1826 was referred in the synonymy of *Bufo margaritifera* (Laurenti,

1768) by FROST (2002). However, as a substitute name for *Bufo scaber* in the sense referred by SPIX (1824), the name *B. spixii* proposed by FITZINGER (1826) (type-locality, “Provincia Rio de Janeiro”) must be in the synonymy of *B. ornatus* (see HOOGLMOED & GRUBER, 1983). The occurrence of a species identified as *B. crucifer* in the Province Misiones, Argentina, was referred by CEI (1980) and STRANECK, OLMEDO & CARRIZO (1993). Three specimens from northeastern Argentina (Province Corrientes) were analyzed in this study and identified as *B. ornatus*. However, additional samples of these apparently disjunct populations are necessary for a more conclusive identification.

Table 2. Descriptive statistics of measurements of males of *Bufo ornatus*.

CHARACTERS	AVERAGE	MINIMUM	MAXIMUM	SD
SVL	63.57	54.5	74.9	4.35
HL	20.96	16.0	25.9	2.06
HW	22.79	19.3	27.6	1.76
ICD	4.98	3.9	6.4	0.57
IND	3.44	2.5	4.7	0.57
END	4.72	3.6	6.3	0.53
ED	6.42	5.2	7.7	0.58
UEW	5.18	4.4	6.0	0.34
IOD	7.94	5.5	10.2	0.95
EMD	2.85	2.1	5.4	0.55
CRL	4.52	3.2	5.9	0.59
STR	3.19	1.9	4.6	0.59
ETD	1.95	1.0	3.5	0.54
TD	3.89	2.9	4.9	0.43
TH	4.63	3.3	5.6	0.49
IPD	12.53	10.1	16.2	1.24
FAR	14.83	12.0	18.1	1.22
UAR	21.30	16.7	28.3	2.24
ICTW	2.99	2.1	3.7	0.36
ICTL	2.29	1.5	3.4	0.35
HAL	6.08	4.8	7.6	0.60
AGD	23.38	16.7	31.7	3.13
THL	26.92	21.3	32.7	2.18
TBL	29.21	23.1	34.3	2.01
TAL	17.18	13.8	21.0	1.31

N=82, (SD) standard deviation.

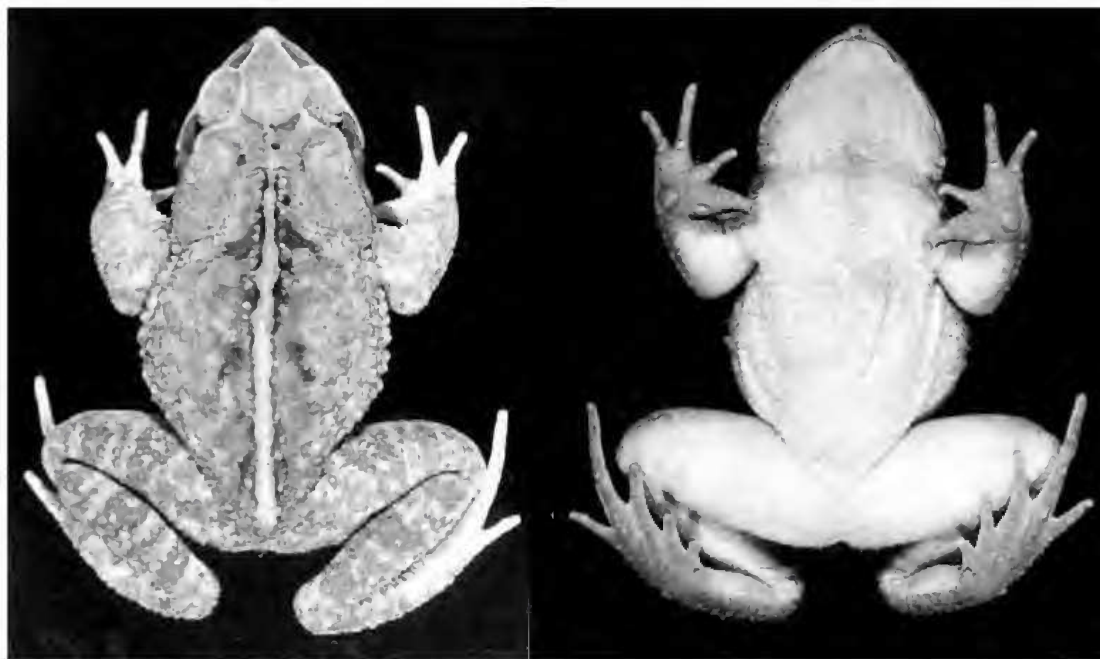
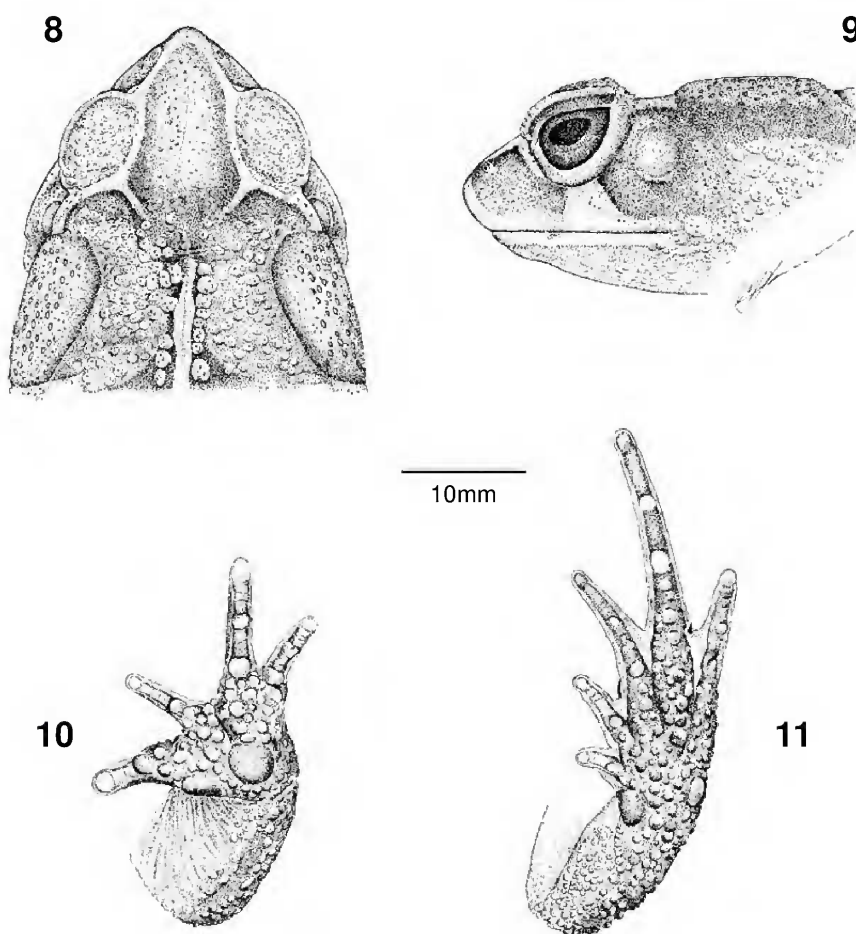


Fig.7- *Bufo ornatus* Spix, 1824 (JJ 6377, adult ♂), dorsal and ventral views.



Bufo ornatus Spix, 1824 (JJ 6377, adult ♂): fig.8- dorsal view of head; fig.9- lateral view of head; fig.10- hand; fig.11- foot.

Bufo henseli A.Lutz, 1934, revalidated
(Figs.12-16)

Bufo crucifer var. *henseli* A.LUTZ, 1934.

Types – Holotype originally in the AL-MN collection, currently missing. The type-locality is the Municipality of São Bento do Sul (28°42'S, 49°30'W), State of Santa Catarina, Brazil.

Diagnosis – (1) The smallest species of the group (SVL 51.6-63.9mm in males; 64.4-78.9mm in females); (2) head approximately as long as wide, without clear subdivision between head and body in dorsal view; (3) snout sub-elliptical in dorsal view; (4) cranial crests poorly developed, sometimes some of them absent; (5) parotoid glands long, narrow, never overhanging the lateral edges of body dorsally; (6) first tubercle of the lateral row never fused to parotoid gland; (7) in life, conspicuous yellow marks near the cloaca and on posterior surface of thighs; (8) dorsal color pattern generally very adorned with markings on head, body, and limbs, resembling lichens; color varying from olive, dark brown to gray; vertebral line always present, beginning at rostral region and finishing at the urostile, generally delimited by black marks; (9) a row of minuscule tubercles on ventral surface of tarsus.

Comparison with other species – *Bufo henseli* differs from *B. abei* sp.nov. by the smaller size (average SVL of *B. henseli* 58.3mm; of *B. abei* sp.nov. 65.6mm) and by the long and narrow parotoid glands (generally triangular in *B. abei* sp.nov.); in life, by the yellow marks near the cloaca and on posterior surface of thighs (absent in *B. abei* sp.nov.). Differs from *B. pombali* sp.nov. by the smaller size (average SVL of *B. pombali* sp.nov. 73.3mm), snout sub-elliptical in dorsal view (rounded in *B. pombali* sp.nov.), and by the presence of a row of minuscule tubercles on ventral surface of tarsus, generally almost imperceptible (a tarsal fringe in *B. pombali* sp.nov.). For comparisons with *B. crucifer* and *B. ornatus*, see previous accounts.

Description – Descriptive statistics in table 3. A small sized species for the group (SVL 51.6-63.9mm in males; 64.4-78.9mm in females); robust build; no clear subdivision between head and body in dorsal view (SVL/HW=2.97); head approximately as long as wide (HW/HL=1.02); narrow and long parotoid glands, never subdivided, never overhanging the lateral edges

of body dorsally; first tubercle of the lateral row never connected to parotoid gland; snout generally sub-elliptical in dorsal view, rounded in lateral view; cranial crests usually inconspicuous, with total absence of some of them in some specimens; weak orbital ridge; roof of head slightly concave; eyes slightly protruding; sub-ocular band conspicuous, contrasting, triangular, usually sharply delimited; width of upper eyelid about 63% of interorbital distance; nostrils protruding; inter-nostril region straight, bordered by the canthal ridges; canthus rostralis straight; loreal region slightly concave; choanae large, rounded; tongue narrow, long, free, wider in the posterior portion; tongue length three times its width; vocal sac single, subgular, moderately developed; a row of small tubercles not always present or easily noticeable starting at the corner of mouth and finishing close to the arm insertion; eye-nostril distance about 77% of eye diameter; inter-nostril distance smaller than tympanum diameter; tympanum distinct, medium sized (TD/ED=0.60), generally rounded and not connected to the supra-tympanic ridge; a integumentary fold can cover the posterior region of the tympanum in the largest specimens. Forelimbs short, slightly hypertrophied; diameter of forearms comparable to that of upper arms; hands large; fingers long, robust, slightly fringed; webbing absent; relative lengths of fingers II $\approx$ IV<I<III; inner metacarpal tubercle generally flat, keratinized; external metacarpal tubercle flat, triangular to rounded; subarticular tubercles conspicuous, elevated. Tibia length slightly greater than thigh length; sum of tibia and thigh lengths about 89% of SVL; foot with toes long, robust, relative lengths of toes I<II<V<III<IV; plantar webbing formula I1-2II1-3III2-4IV4-2V; inner metatarsal tubercle elevated, elliptical; external metatarsal tubercle elliptical to elongate; subarticular tubercles small, elevated; a row of minuscule keratinized tubercles on ventral surface of tarsus, generally starting close to inner metatarsal tubercle and finishing before the tibia-heel articulation.

Color – In life, dorsal color varying from olive, dark brown to gray; specimens generally very adorned on head, dorsal region, and limbs, presenting marks resembling lichens; in some populations a more uniform brownish dorsal pattern occurs with few marks, generally limited to the area of head; ochre vertebral line always present, starting at rostral region and finishing at the urostile; when thicker, the vertebral line

is delimited by black markings; ventral area generally pale cream with scattered gray dots; some specimens have stripes with a marbled pattern of gray dots and pale yellow in the groin area; conspicuous yellow marks near the cloaca and on posterior surface of thighs. In preservative, dorsal area with the same pattern described for preserved specimens, but faint; venter and marks near the cloaca and on posterior surface of thighs, whitish.

Geographic distribution – Distributed throughout the Atlantic Rain Forest from southern State of Santa Catarina to the coast of the State of Rio Grande do Sul (including the plateau and interior), Brazil (Fig.6). The distribution of this species is apparently limited to the north by the western side of the Serra Geral mountains.

Remarks – According to BOKERMANN (1966), the type-locality mentioned in A.LUTZ (1934) for *B. henseli* is currently São Bento do Sul, in the State of Santa Catarina, Brazil. In the description of the holotype from São Bento do Sul, A.LUTZ (1934) compared it to a specimen from Gramado, State of Rio Grande do Sul, Brazil, and indicated that both specimens would belong to the same subspecies, *B. crucifer henseli*. He also called attention to the shape of the parotoid glands and to the conspicuous yellow markings on the posterior surface of thighs. Morphologically, *B. henseli* is the most distinctive species of the *B. crucifer* group.

Table 3. Descriptive statistics of measurements of males of *Bufo henseli*.

CHARACTERS	AVERAGE	MINIMUM	MAXIMUM	SD
SVL	58.27	51.6	63.9	3.72
HL	19.30	17.1	21.5	1.19
HW	19.87	17.8	21.9	1.23
ICD	4.49	4.0	5.2	0.37
IND	2.77	1.9	3.5	0.43
END	4.37	3.8	5.0	0.40
ED	5.69	5.0	6.6	0.45
UEW	4.57	4.1	5.1	0.36
IOD	7.08	6.1	8.2	0.63
EMD	2.37	1.9	3.1	0.36
CRL	3.79	2.9	5.1	0.58
STR	2.12	1.2	2.9	0.58
ETD	1.43	1.0	2.1	0.34
TD	3.43	2.6	4.1	0.42
TH	4.24	3.5	4.8	0.45
IPD	10.59	9.6	11.8	0.66
FAR	13.31	11.3	14.6	1.16
UAR	19.58	15.8	23.8	2.22
ICTW	2.56	2.1	3.3	0.32
ICTL	2.34	1.1	3.1	0.59
HAL	5.51	4.8	6.1	0.41
AGD	19.83	16.1	23.4	2.15
THL	24.81	22.1	27.6	1.88
TBL	26.69	23.7	29.7	1.85
TAL	15.78	14.0	18.4	1.34

(N=13; SD=standard deviation)

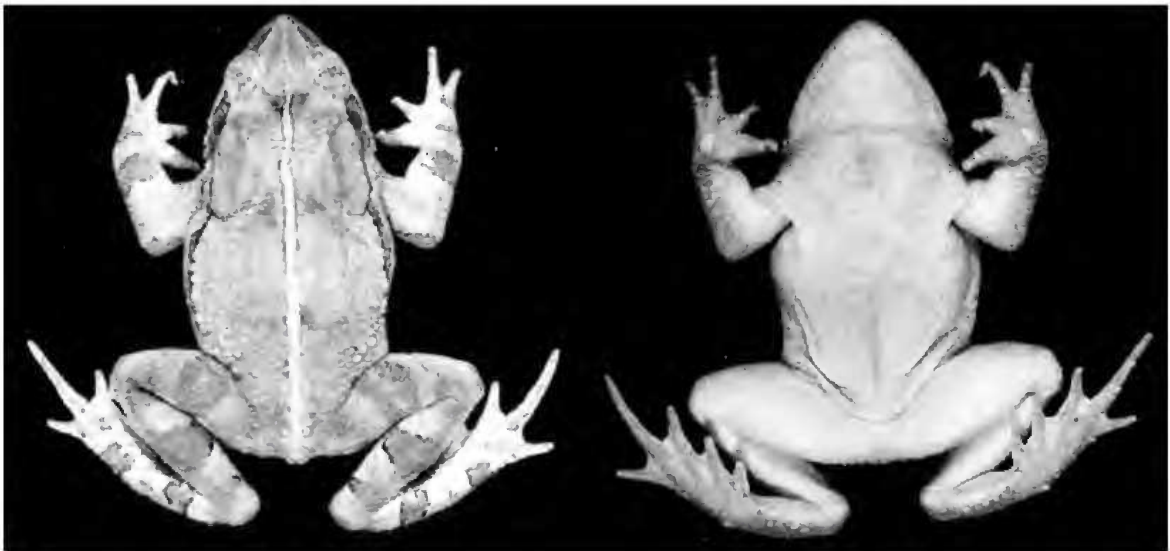
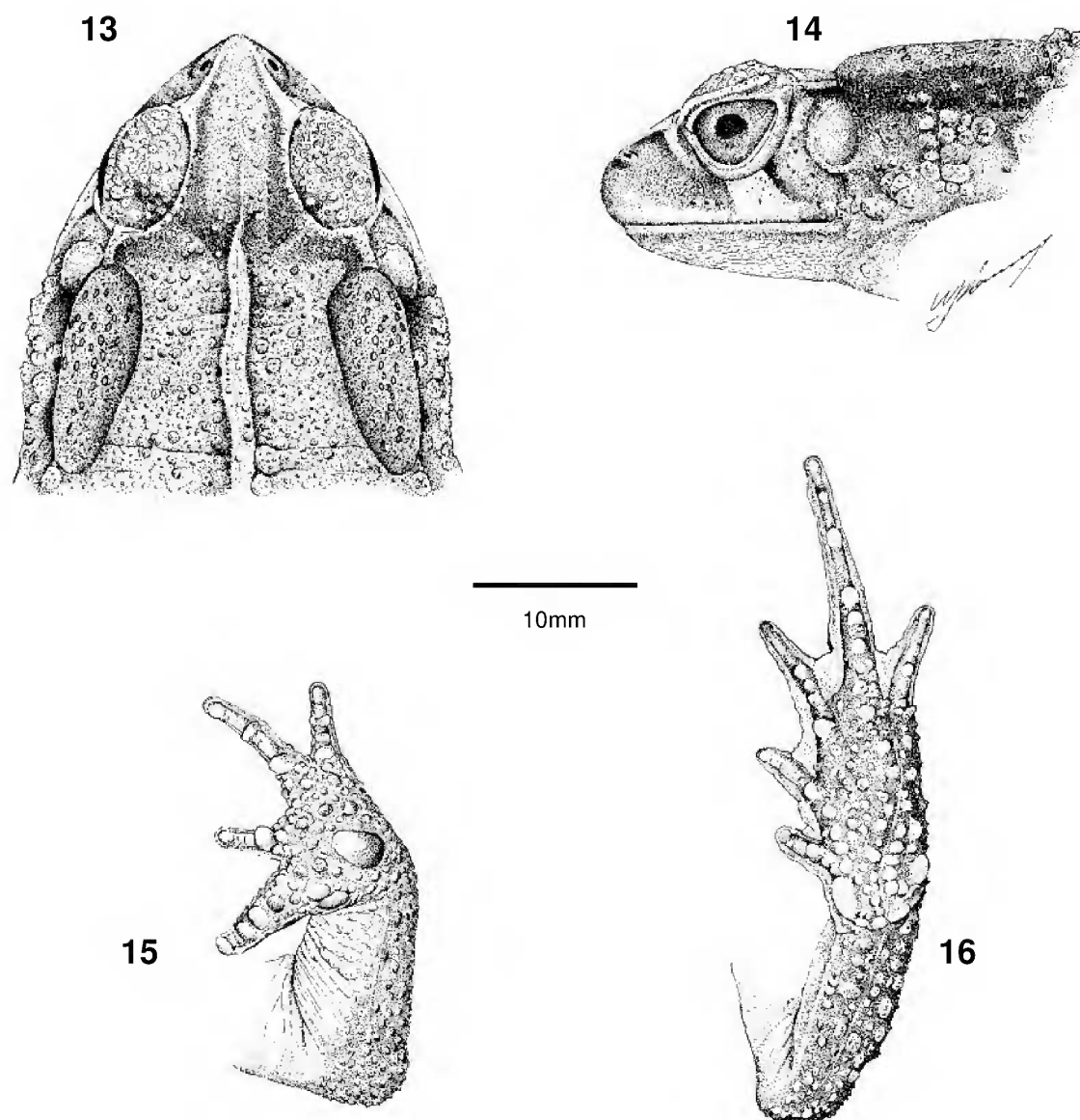


Fig.12- *Bufo henseli* A.Lutz, 1934 (MCN 9996, adult ♂), dorsal and ventral views.



Bufo henseli A.Lutz, 1934 (MCN 9996, adult ♂): fig.13- dorsal view of head; fig.14- lateral view of head; fig.15- hand; fig.16- foot.

Bufo abei sp.nov.
(Figs.17-21)

Holotype – BRAZIL, SANTA CATARINA, Córrego Grande, Municipality of Florianópolis (25°28'S, 48°50'W, sea level), MNRJ 24963, adult male, P.C.A.Garcia col., 23/IV/1990.

Paratypes – Three males and one female collected with the holotype: MNRJ 24964-24967.

Diagnosis – (1) A medium sized species for the group (SVL 57.0-76.4mm in males; 60.4-83.9mm in females); (2) head slightly wider than long, no clear subdivision between head and body in dorsal

view; (3) snout sub-elliptical in dorsal view; (4) low cranial crests; (5) small triangular parotoid glands, never exceeding the lateral edges of body dorsally; (6) first tubercle of lateral row always connected to the parotoid gland; (7) in life, absence of yellow marks near the cloaca and on posterior surface of thighs; (8) triangular sub-ocular band conspicuous, contrasting, well delimited; (9) a row of small tubercles on the ventral surface of tarsus, never forming a fringe.

Comparison with other species – *Bufo abei* sp.nov. differs from *B. pombali* sp.nov. by the smaller size (average SVL of *B. abei* sp.nov. 65.6mm; of *B. pombali*

sp.nov. 73.3mm), less robust build, absence of a clear subdivision between head and body in dorsal view, snout sub-elliptical in dorsal view (rounded in *B. pombali* sp.nov.), presence of triangular parotoid glands, not exceeding the lateral edges of body dorsally (sub-elliptical and enlarged on anterior region, exceeding the lateral edges of the body in *B. pombali* sp.nov.); in life, *B. abei* sp.nov. does not have yellow marks near the cloaca and on posterior surface of thighs (always present in *B. pombali* sp.nov.); *B. abei* sp.nov. has a line of small tubercles on the ventral surface of tarsus (tubercles forming a conspicuous fringe in *B. pombali* sp.nov.). For comparisons with *B. crucifer*, *B. ornatus*, and *B. henseli*, see previous accounts.

Description – Measurements of the holotype and paratypes in table 4; descriptive statistics in table

5. A medium sized species for the group (SVL 57.0-76.4mm in males; 60.4-83.9mm in females); robust build; no clear subdivision between head and body in dorsal view (SVL/HW=2.84); head slightly wider than long (HW/HL=1.04); small parotoid glands, usually not subdivided, triangular, enlarged on anterior portion, sometimes elliptical, never exceeding the lateral edges of body dorsally; first tubercle of lateral row always connected to parotoid gland; snout sub-elliptical in dorsal view, sub-acute in lateral view; low cranial crests, with pre-ocular sometimes absent; moderate orbital ridge; roof of head concave; eyes protruding; width of upper eyelid about 60% of interorbital distance; nostrils prominent; inter-nostril region straight, bordered by canthal ridges; canthus rostralis straight;

Table 4. Measurements (in mm) of the holotype (H) and paratypes (P) of *B. abei* sp.nov.

CHARACTERS	MNRJ 4963 (H ♂)	MNRJ 24964 (P ♂)	MNRJ 24965 (P ♂)	MNRJ 24966 (P ♂)	MNRJ 24967 (P ♀)
SVL	61.3	71.6	62.1	70.4	81.9
HL	21.7	24.1	21.2	23.7	27.1
HW	22.2	25.1	22.2	25.4	29.1
ICD	4.8	5.2	5.2	5.3	5.6
IND	3.4	3.6	3.4	4.0	4.6
END	5.2	5.6	4.4	5.8	6.3
ED	6.4	7.6	6.5	8.1	7.9
UEW	5.0	5.9	5.3	6.2	5.7
IOD	8.9	9.5	8.5	9.2	10.8
EMD	2.8	2.4	2.7	2.9	3.2
CRL	4.6	5.2	4.4	5.6	5.3
STR	2.8	3.3	3.4	3.6	4.1
ETD	1.4	1.5	1.2	1.3	1.6
TD	3.8	4.4	4.2	4.7	4.7
TH	4.6	4.9	4.4	4.9	6.2
IPD	12.5	15.0	12.5	13.7	15.3
FAR	14.6	16.1	15.4	16.8	16.6
UAR	23.8	25.4	23.1	25.9	26.4
ICTW	2.9	3.4	2.6	4.4	2.6
ICTL	2.4	2.8	2.5	3.2	3.0
HAL	6.0	7.7	6.1	7.6	7.6
AGD	23.1	27.7	21.0	23.4	35.6
THL	25.2	29.7	26.4	29.7	29.7
TBL	27.8	30.4	28.9	30.8	33.0
TAL	16.8	18.5	16.9	17.1	19.0

loreal region moderately concave; choanae large, rounded to elliptical; tongue oval, long, free, wider on posterior portion; tongue length about twice its width; vocal sac single, subgular, moderately developed; a line of small keratinized tubercles starting at the corner of mouth and finishing near the arm insertion; eye-nostril distance about 74% of eye diameter; inter-nostril distance smaller than tympanum diameter; tympanum distinct, large ($TD/ED=0.62$), generally rounded when free, elliptical when associated to the supra-tympanic ridge. Forelimbs long, diameter of forearm generally comparable to upper arm; hands medium sized; fingers long, slender, slightly fringed; webbing absent; relative lengths of fingers $II < IV < I < III$; inner metacarpal tubercle slightly protuberant, generally keratinized; external metacarpal tubercle flat, triangular to elliptical; subarticular tubercles conspicuous, protuberant, rounded. Tibia length slightly larger than thigh length; sum of tibia and thigh lengths about 86% of SVL; foot with toes long, slender; relative lengths of toes $I < II < V < III < IV$; plantar webbing formula $I2-3II2-3III2-3^{1/2}IV3^{1/2}-2V$; inner metatarsal tubercle elevated, elliptical; external metatarsal tubercle small, rounded; subarticular tubercles small, elevated; a line of small tubercles on

ventral surface of tarsus, never forming a fringe.

Color – In life, a conspicuous cream triangular sub-ocular band; dorsal color varying from ochre, olive, dark brown to brick red, the latter giving a velvety aspect to the specimen; ochre vertebral line always present, starting at the rostral region and finishing at urostyle; when thicker, vertebral line delimited by black markings; dark transverse stripes on limbs generally well defined; ventral area with variable color, from ochre to gray scattered dots, which decreases in intensity in direction of thighs; subgular region darker in males. In preserved specimens, dorsal and ventral color follow the same pattern for live specimens, but the color may fade due to action of the preservative.

Geographic distribution – Distributed throughout the Atlantic Rain Forest from the State of Paraná to southern State of Santa Catarina and areas of the northern State of Rio Grande do Sul (Fig.6), limited by the hills of Serra do Mar to the north and Serra Geral to the west.

Etymology – The specific name honors our friend Dr. Augusto Shinia Abe (Universidade Estadual Paulista, Campus de Rio Claro, SP, Brazil) for his contributions to the knowledge of the physiology of Neotropical amphibians and reptiles.

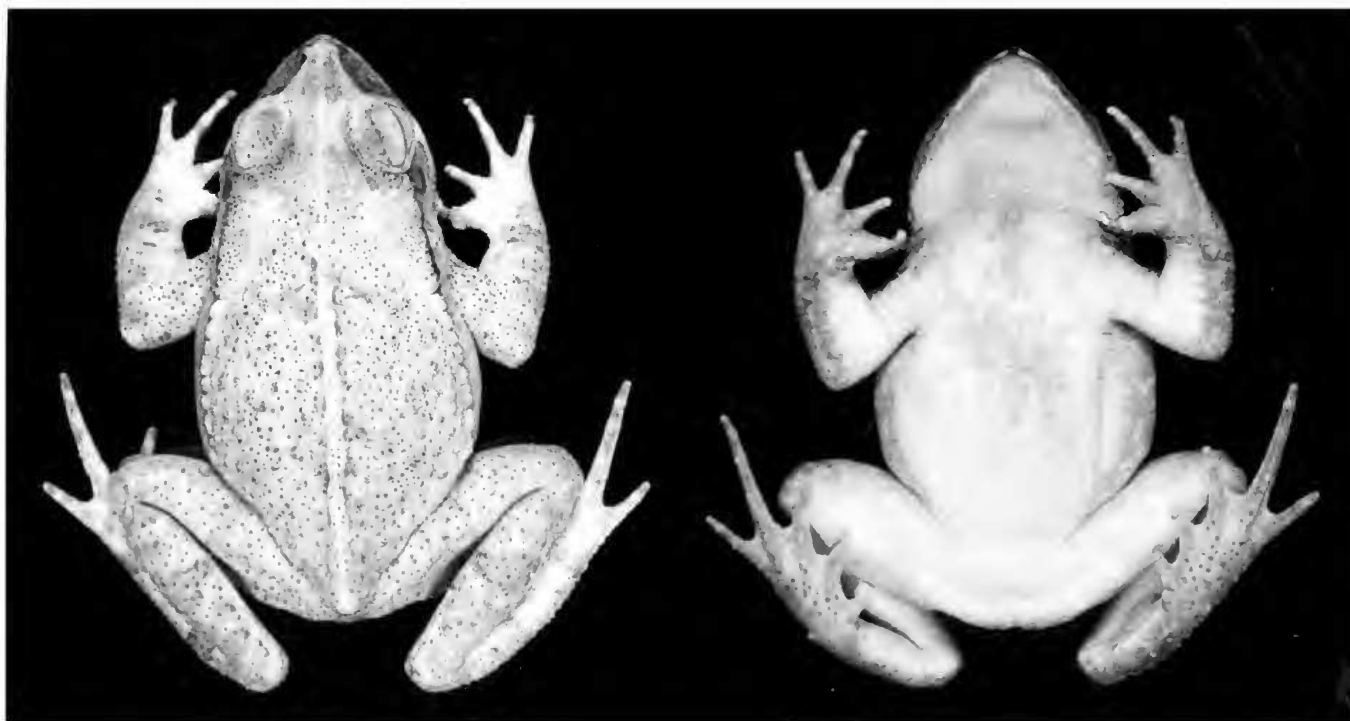
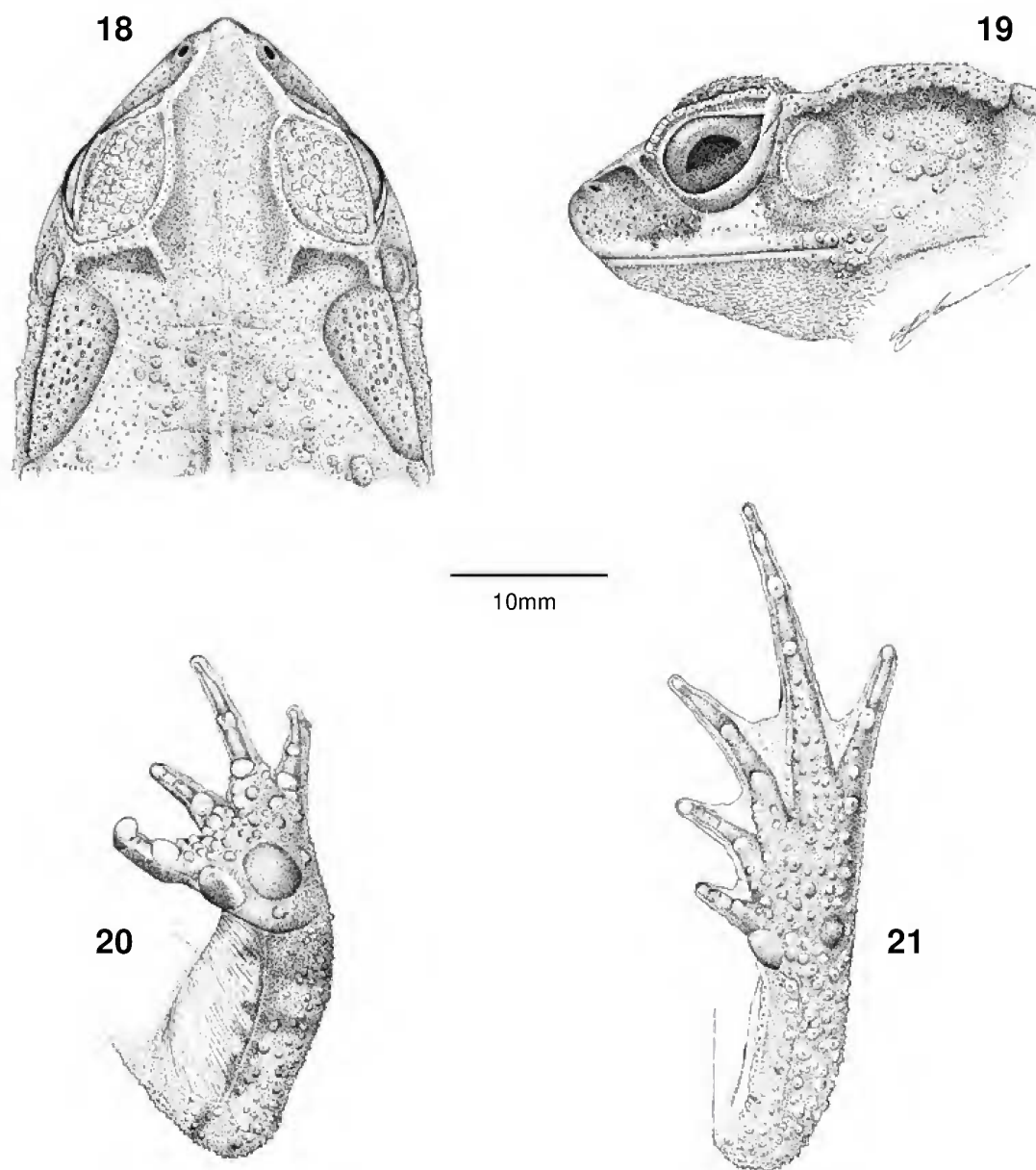


Fig.17- *Bufo abei* sp.nov., holotype (MNRJ 24963, adult ♂), dorsal and ventral views.



Bufo abei sp.nov., holotype (MNRJ 24963, adult ♂); fig.18- dorsal view of head; fig.19- lateral view of head; fig.20- hand; fig.21- foot.

Bufo pombali sp.nov.
(Figs.22-26)

Holotype – BRAZIL, MINAS GERAIS, Reserva Biológica de Peti, Municipality of São Gonçalo do Rio Abaixo (19°49'S, 43°21'W, altitude 650m), MNRJ 22311, adult male, G.Kisteumacher col., 13-14/VI/1986.

Paratypes – Eight males and five females collected at the type-locality: MNRJ 22291-22294, MNRJ 22298-22300, MNRJ 22310, MNRJ 22219, MNRJ 22297, MNRJ 23694-23696.

Diagnosis – (1) A large sized species for the group

(SVL 54.5-92.7mm in males; 74.9-118.7mm in females); (2) head wider than long, with clear subdivision between head and body in dorsal view; (3) snout rounded in dorsal view; (4) conspicuous cranial crests; (5) parotoid glands usually ovoid, not subdivided, enlarged on anterior portion, overhanging the lateral edges of body laterally; (6) first tubercle of lateral row always connected to the parotoid gland; (7) dark gray stripes on limbs, varying from complete to a faint pattern; (8) in life, yellow marks near cloaca and on posterior surface of thighs; (9) a row of tubercles on ventral surface of tarsus, which becomes a fringe in large specimens.

Comparison with other species – For comparisons with *B. crucifer*, *B. ornatus*, *B. henseli*, and *B. abei* sp.nov., see previous accounts.

Description – Measurements of the holotype and paratypes in table 6; descriptive statistics in table 7. A large sized species for the group (SVL 54.5–92.7mm in males; 74.90–118.7mm in females); robust build; clear subdivision between head and body in dorsal view (SVL/HW=2.74); head wider than long (HW/HL=1.12); parotoid glands usually ovoid, not subdivided, enlarged on anterior portion, overhanging the lateral edges of body laterally; first tubercle of lateral row always connected to the parotoid gland; snout rounded in dorsal and in lateral views; conspicuous cranial crests; roof of head depressed, forming a concavity between crests; pre-orbital crests always present, well defined; eyes protruding; width of upper eyelid about 60% of interorbital distance; nostrils prominent; inter-nostril region straight, delimited by the canthal ridges; canthus rostralis straight; loreal region concave; choanae large, rounded; tongue oval, long, free, wider in posterior portion; tongue length about twice the width; vocal sac single, subgular, moderately developed; a row of small keratinized tubercles starting at the corner of mouth and finishing near the insertion of arm; eye-nostril distance about 73% of eye diameter; inter-nostril distance equivalent to tympanum diameter; tympanum distinct, small (TD/ED=0.56), rounded when free, elliptical when associated to supratympanic ridge or to a skin fold on posterior border. Forelimbs long, diameter of forearm larger than upper arm; hands large; fingers medium-sized, slightly fringed; webbing absent; relative lengths of fingers II<IV<I<III; inner metacarpal tubercle rounded, slightly protuberant, generally keratinized; external metacarpal tubercle flat, varying from circular to elliptical or triangular; subarticular tubercles conspicuous, elliptical, elevated. Tibia length larger than thigh length; sum of tibia and thigh lengths about 86% of SVL; foot with toes long, slender; relative lengths of toes I<II<V<III<IV; plantar webbing formula I1-2II1-3III2-4IV4-2^{1/3}V; inner metatarsal tubercle elliptical, elevated; external metatarsal tubercle rounded; subarticular tubercles small, elevated; a fringe along the ventral surface of tarsus, beginning close to the inner metatarsal tubercle and finishing before the tibia-heel articulation.

Color – In preserved specimens, dorsal color generally uniform, varying from cream, greenish-

yellow, olive to sepia; light vertebral line usually narrow; when the vertebral line is thick, it is bordered by approximately symmetrical dark brown to sepia or black marks; ventral area with variable color, from ochre, cream to sprinkled gray mottling, which become faint in direction of thighs; yellow marks always present near cloaca and on posterior surface of thighs; subgular region darker in males. Color in life unknown.

Geographic distribution – Distributed throughout the Atlantic Rain Forest and in its transitional areas with the Cerrado, in the State of Minas Gerais, Brazil (Fig.6).

Etymology – The specific name honors our friend Dr. José P. Pombal Jr. (MNRJ) for his extensive contribution to the knowledge of the biology and taxonomy of Brazilian amphibians.

Table 5. Descriptive statistics of measurements of males of *Bufo abei* sp.nov.

CHARACTERS	AVERAGE	MINIMUM	MAXIMUM	SD
SVL	65.70	57.0	76.4	5.17
HL	22.29	15.1	26.0	2.28
HW	23.20	19.9	27.7	2.07
ICD	5.21	4.3	7.0	0.57
IND	3.37	2.3	4.8	0.69
END	5.00	4.1	7.0	0.63
ED	6.73	5.4	8.1	0.69
UEW	5.12	4.0	6.2	0.52
IOD	8.40	6.8	10.1	0.82
EMD	2.78	2.0	4.1	0.49
CRL	4.99	4.0	6.2	0.56
STR	3.35	2.2	4.3	0.56
ETD	1.76	1.2	3.0	0.49
TD	4.14	3.2	5.4	0.56
TH	4.78	3.5	6.3	0.65
IPD	12.56	10.3	15.2	1.29
FAR	15.48	12.8	18.3	1.50
UAR	22.47	16.9	27.2	2.25
ICTW	3.01	2.0	4.4	0.59
ICTL	2.43	1.8	3.5	0.46
HAL	5.97	4.3	7.7	0.97
AGD	23.53	18.3	29.6	2.87
THL	27.51	23.6	30.7	2.16
TBL	30.22	25.8	33.4	2.19
TAL	17.61	13.9	20.4	1.52

N=30; (SD) standard deviation.

Remarks – Based on external morphology, A.LUTZ (1934) considered that *B. scaber* could be a transitional form between *B. ornatus* and *B. cinctus* (junior synonym of *B. crucifer*, described from the State of Espírito Santo, Brazil), and mentioned that the specimens from Minas Gerais would be similar to *B. scaber*. *Bufo scaber* was described by SPIX (1824) based on specimens from “Provincia Rio de Janeiro”, and therefore *B. scaber* “sensu” Spix, 1824 is a junior synonym of *B. ornatus*. Lutz’s statement and the geographic distribution reinforce the idea that *B. pombali* sp.nov. is a species with intermediary characteristics between *B. ornatus* and *B. crucifer*.

MORPHOMETRIC ANALYSIS OF THE *BUFO CRUCIFER* SPECIES GROUP

The canonical analysis was used to analyze morphologic variation among the five species herein recognized. Twenty-five significant characters ($P < 0.05$) were used. The characters, the resulted coefficients, and loadings are listed in tables 8 and 9. Four significant canonical axes were obtained, representing 100% of the total variation. The

individual scores were projected in the reduced space of the first and second axes (Fig.27). The projection of the scores on the other two vectors did not show additional discrimination. Along the first canonical axis, the sample of *B. crucifer* is completely discriminated from the sample of *B. henseli* and *B. abei* sp.nov.; the sample of *B. ornatus* is partially discriminated from *B. crucifer* and *B. henseli*, and the sample of *B. pombali* sp.nov. is also partially discriminated from the sample of *B. crucifer* and *B. henseli*.

Along the second canonical axis, the sample of *B. pombali* sp.nov. is almost completely discriminated from *B. henseli* and partially discriminated from *B. crucifer*. The samples of *B. ornatus* and *B. abei* sp.nov. are not discriminated by the projection of the scores of the canonical variables.

The degree of contribution of each variable in the first canonical axis (decreasing order) is: IPD, HW, IC, IOD, SVL, THL, UEW, HL, FAR, STR, ED, END, HAL, TAL, TD, ETD, CRL, EMD, UAR, TBL, TH, AGD, ICTW, IND, and ICTL; in the second axis: IND, FAR, UAR, SVL, ED, EMD, ICTW, IPD, IC, HW, UEW, IOD, CRL, END, HL, and TH.

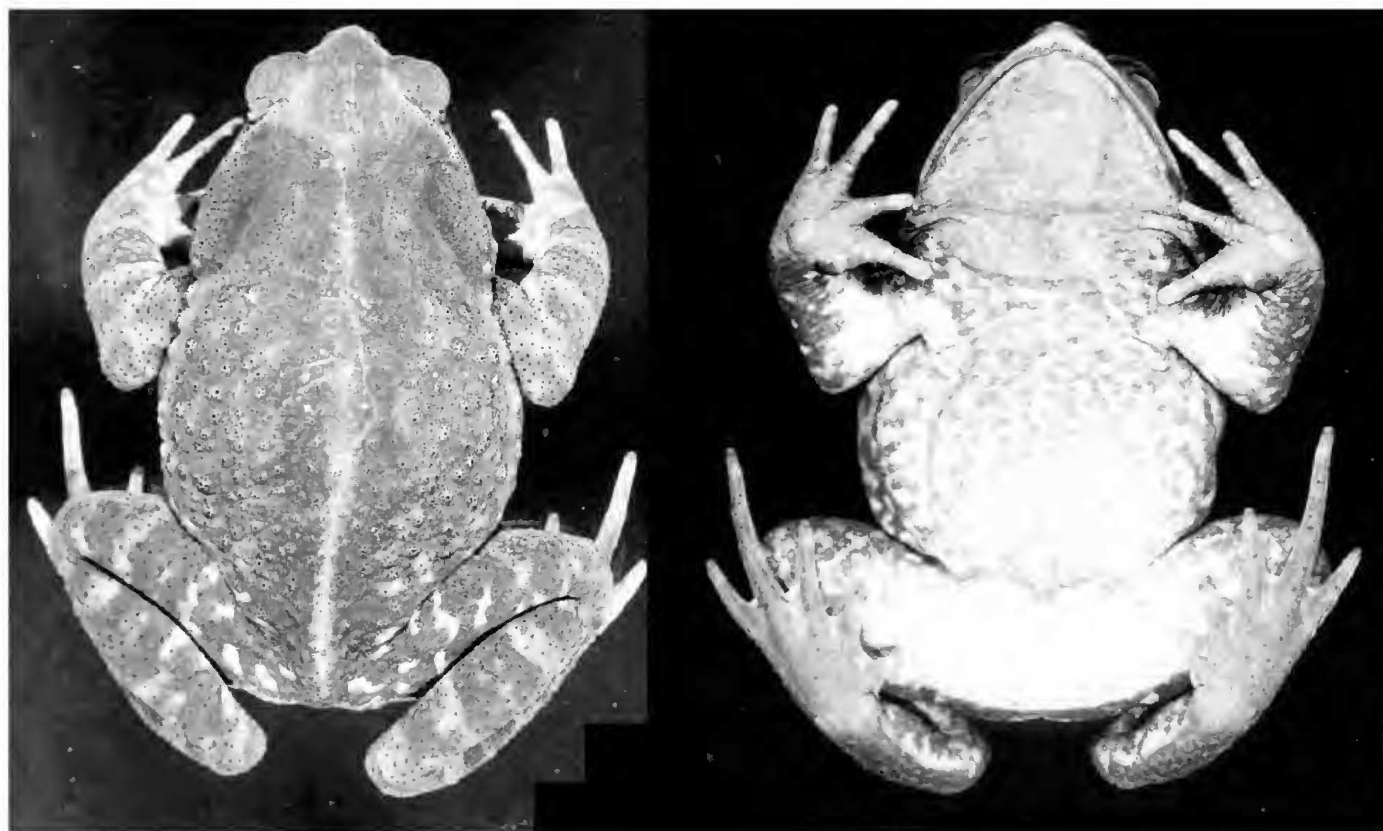


Fig.22- *Bufo pombali* sp.nov., holotype (MNRJ 22311, adult ♂), dorsal and ventral views.

Table 6. Measurements (in mm) of the holotype (H) and paratypes (P) of *B. pombali* sp.nov.

CHARACTERS	MNRJ 22311 (H ♂)	MNRJ 22291 (P ♂)	MNRJ 22292 (P ♂)	MNRJ 22293 (P ♂)	MNRJ 22294 (P ♂)	MNRJ 22298 (P ♂)	MNRJ 22299 (P ♂)
SVL	89.0	83.0	72.3	82.6	78.8	87.6	78.6
HL	28.4	27.6	24.7	27.5	26.2	29.8	27.1
HW	31.6	30.6	27.1	31.2	28.7	34.6	30.2
ICD	6.3	6.1	6.0	6.6	6.2	7.5	7.0
IND	4.7	3.9	3.5	3.6	4.0	5.2	4.7
END	6.2	5.1	5.3	6.5	5.9	7.4	5.7
ED	8.4	8.6	6.7	7.9	6.4	7.8	7.9
UEW	6.6	6.8	5.9	6.5	5.6	6.7	5.6
IOD	12.3	11.5	10.5	11.6	11.2	12.9	13.1
EMD	4.0	3.6	2.9	3.9	3.5	4.7	3.5
CRL	6.4	5.7	5.2	6.6	5.4	7.0	5.6
STR	4.9	3.6	3.5	3.7	3.6	4.2	4.0
ETD	2.4	2.0	2.1	2.1	2.5	2.5	1.9
TD	4.8	4.4	4.0	5.0	4.4	5.6	5.4
TH	6.2	5.3	4.88	6.0	5.5	6.2	5.9
IPD	19.2	19.0	18.1	17.4	18.0	18.0	16.2
FAR	20.4	19.3	18.0	19.2	19.0	21.8	20.7
UAR	30.8	30.0	25.0	28.6	27.6	32.0	27.8
ICTW	3.9	4.4	3.0	3.9	4.0	4.3	3.2
ICTL	3.5	3.5	2.6	3.9	2.8	3.2	2.8
HAL	8.9	7.8	7.2	8.1	7.2	9.4	8.1
AGD	29.6	26.5	25.4	29.4	25.2	32.9	25.4
THL	35.9	33.8	29.5	33.8	29.6	36.5	34.8
TBL	39.1	38.4	33.6	38.0	36.6	41.6	37.7
TAL	20.6	21.6	19.7	22.6	20.0	22.6	22.0
	MNRJ 22300 (P ♂)	MNRJ 22310 (P ♂)	MNRJ 22219 (P ♀)	MNRJ 22297 (P ♀)	MNRJ 23694 (P ♀)	MNRJ 23695 (P ♀)	MNRJ 23696 (P ♀)
SVL	72.6	84.4	92.8	97.4	118.7	109.0	110.9
HL	24.5	29.5	30.4	33.9	41.0	36.2	36.5
HW	25.5	31.4	34.9	36.7	47.1	42.0	42.7
ICD	5.8	6.5	7.4	7.7	8.9	7.6	8.4
IND	4.4	4.8	4.5	6.5	6.5	6.6	6.1
END	4.9	6.5	6.7	6.5	7.3	7.2	7.3
ED	7.2	8.0	7.5	8.3	10.2	9.1	9.8
UEW	5.7	6.1	6.4	7.2	8.5	7.8	8.7
IOD	10.2	11.8	13.4	10.0	16.2	14.1	14.3
EMD	3.4	4.4	4.1	4.1	5.2	4.7	5.0
CRL	5.0	6.0	7.5	7.7	8.0	7.5	7.9
STR	3.1	4.1	5.7	5.3	5.5	4.9	5.2
ETD	1.4	1.8	3.3	2.4	3.1	3.5	3.1
TD	4.8	5.0	4.6	6.1	6.7	4.5	5.6
TH	5.7	6.2	5.6	7.1	8.3	6.5	6.6
IPD	14.0	16.8	18.4	19.0	22.2	21.2	23.8
FAR	18.1	19.3	21.3	24.6	25.7	22.7	23.4
UAR	26.1	28.9	28.6	32.7	38.9	33.1	37.8
ICTW	3.2	3.6	3.0	3.3	3.7	3.2	3.2
ICTL	2.5	3.5	4.7	3.5	5.8	4.4	5.0
HAL	7.3	8.2	8.6	9.5	12.6	10.9	12.2
AGD	24.8	32.3	38.3	39.1	46.7	49.8	52.4
THL	30.3	33.8	34.8	38.7	46.7	40.2	40.2
TBL	33.0	36.9	37.8	43.2	49.0	45.2	45.8
TAL	17.7	21.2	22.1	25.1	27.7	25.8	26.8

Table 7. Descriptive statistics of measurements of males of *Bufo pombali* sp.nov.

CHARACTERS	AVERAGE	MINIMUM	MAXIMUM	SD
SVL	74.02	54.5	92.7	10.03
HL	24.23	16.7	31.1	3.79
HW	27.06	18.6	35.7	4.22
ICD	5.97	4.0	7.9	0.74
IND	4.12	2.9	6.7	0.67
END	5.40	4.0	7.4	0.71
ED	7.35	5.3	9.5	1.02
UEW	5.70	4.1	7.3	0.80
IOD	9.58	5.3	13.1	1.74
EMD	3.39	2.2	4.7	0.56
CRL	5.27	4.0	7.3	0.72
STR	3.51	2.0	4.9	0.67
ETD	2.19	1.1	3.5	0.57
TD	4.16	2.9	5.6	0.57
TH	4.97	3.4	6.2	0.60
IPD	15.42	10.4	21.8	2.87
FAR	17.45	12.9	22.1	2.33
UAR	25.03	16.6	32.0	3.74
ICTW	3.35	2.4	4.9	0.56
ICTL	2.59	1.7	4.1	0.54
HAL	7.04	5.2	9.4	0.98
AGD	27.00	19.0	37.9	4.29
THL	30.21	22.2	39.2	3.68
TBL	33.29	24.0	41.8	4.20
TAL	19.79	14.9	24.5	2.14

N=60, (SD) standard deviation.

DISCUSSION

Systematic review – Only one name, *Bufo levicristatus* Boettger, 1885, a species described from Paraguay (BOETTGER, 1885a), remains unsolved. This species was synonymized with *B. crucifer* by BOETTGER (1885b), BOULENGER (1886), and by COCHRAN (1955) (as *B. laevicristatus*), as indicated by FROST (2002). The three syntypes of *B. levicristatus* are missing (Axel Kwet, pers. comm.). Moreover, the description in BOETTGER (1885a) was not sufficient to identify to which morphotype of the *B. crucifer* group the species would correspond to or even if the specimens belong to the *B. crucifer* group. The description gives the impression that the specimens may belong to the *B. granulosus* species group, especially because the author compares *B. levicristatus* with *B. dorbignyi* Duméril & Bibron, 1841, a valid species in that group.

ARTIFICIAL KEY TO THE SPECIES OF THE
BUFO CRUCIFER GROUP

- 1. In life, presence of conspicuous yellow or bright spots and/or marks near cloaca and on posterior surface of thighs (in preservative, spots and/or marks whitish cream) 2
- 1'. Absence of such spots/marks 3
- 2. Parotoid glands elongate with the same width from one end to the other. Occurs in the plateau and interior of the states of Santa Catarina and Rio Grande do Sul, Brazil *Bufo henseli* A.Lutz, 1934
- 2'. Parotoid glands with other shapes 4
- 3. In dorsal view, corners of mouth (maxillary bones) prominent; head slightly wider than long. Occurs from southern State of Espírito Santo, through the states of Rio de Janeiro and São Paulo to northern State of Paraná, Brazil *Bufo ornatus* Spix, 1824
- 3'. In dorsal view, corners of mouth (maxillary bones) not prominent, giving a slender, “torpedo” shape to the toad; head not wider than long. Occurs in the coast of the states of Paraná and Santa Catarina to northern Rio Grande do Sul, Brazil *Bufo abei* sp.nov.
- 4. Snout short in lateral view; parotoid glands usually oval, overhanging the edges of body in dorsal view; vertebral line always present, sometimes thick and dark edged. Occurs in the plateau of the State of Minas Gerais, Brazil, limited by the Cerrado domain *Bufo pombali* sp.nov.
- 4'. Snout long in lateral view; parotoid glands elliptical to triangular, usually overhanging the edges of body in dorsal view; vertebral line very thin or absent. Occurs on the coast and towards inland, following the limits of the Atlantic Rain Forest, from the State of Ceará to southern State of Espírito Santo and northeastern State of Minas Gerais, Brazil *Bufo crucifer* Wied-Neuwied, 1821

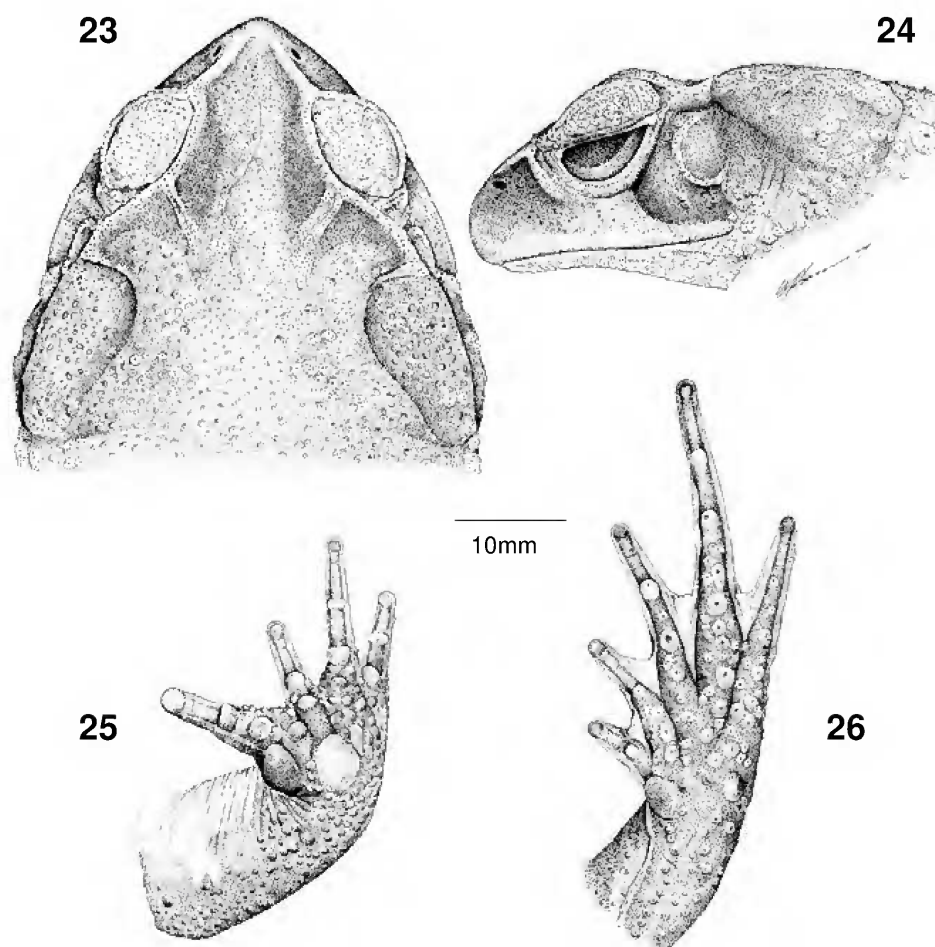
On the other hand, the last paragraph of the description mentions the presence of a dorsal line with dark transverse markings, which is a common color pattern of specimens of the *B. crucifer* species group. It is noteworthy that NORMAN (1994) registered only *B. granulosus major* Müller & Hellmich, 1936 and *B. paracnemis* A.Lutz, 1925 (currently *B. schneideri* Werner, 1894) for the Paraguayan Chaco, without mention of any species of the *B. crucifer* group. Moreover, *B. levicristatus* was described from Paraguay, which borders the distribution area of *B. ornatus* and therefore *B. levicristatus* could be a synonym of the latter. However, if the populations occurring in northeastern Argentina deserve a specific name, *B. levicristatus* may be utilized. As the types of *B. levicristatus* are missing, its identification remains unsolved and it is here considered a *species inquirenda* (ICZN, 1999). We propose that the epithet

B. levicristatus should be removed from the synonymy of any species of the *B. crucifer* group because its maintenance would confuse the understanding of the geographic distribution of them.

MÜLLER (1973) subdivided the Atlantic Rain Forest into three morphoclimatic sub-units: the first to the north of Ilhéus, in the State of Bahia; the second from Ilhéus to Cabo Frio, in the State of Rio de Janeiro; and the third from Cabo Frio to the forested areas of the State of Rio Grande do Sul. According to this classification, *B. crucifer* would be distributed in the first and second sub-units, and all the other species in the third, except for *B. pombali* sp.nov., distributed in the domains of the Central Brazilian Plateau, in the transition from the Atlantic Rain Forest to the Cerrado. The subdivision proposed by MÜLLER (1973) does not fully explain the distribution of the species of the *B. crucifer* group. According to LYNCH (1979), the lowland tropical forests in South America would be constituted by four separated formations, one of which is the Atlantic

Rain Forest in Brazil, the main area of distribution of the *B. crucifer* species group. The Atlantic Rain Forest would be subdivided into seven sub-units or morphoclimatic domains. The first would comprise the Atlantic Rain Forest of states of the Brazilian Northeastern Region, except the State of Bahia, that would form the second sub-unit; the third one would comprise the forested areas in the State of Espírito Santo; the fourth sub-unit would include the coastal areas of the states of Rio de Janeiro and São Paulo; the fifth would comprise the plateau and its transitional areas in the states of São Paulo and Minas Gerais; the sixth sub-unit would comprise the coastal areas of the states of Paraná and Santa Catarina, penetrating a small region in northeastern State of Rio Grande do Sul; the seventh and last sub-unit would be the interior of the states of Santa Catarina and Paraná, and coast and interior of the State of Rio Grande do Sul.

LYNCH's (1979) subdivision seems to better explain the distribution observed for the *B. crucifer*



Bufo pombali sp.nov., holotype (MNRJ 22311, adult ♂): fig.23- dorsal view of head; fig.24- lateral view of head; fig.25- hand; fig.26- foot.

Table 8. Standardized coefficients of the canonical analysis of the 25 morphometric characters of the combined samples of the *B. crucifer* species group.

CHARACTERS	VECTOR 1	VECTOR 2	VECTOR 3	VECTOR 4
SVL	-0.592056	0.273832	-0.286969	0.224876
HL	-0.559373	0.139981	-0.264842	0.299011
HW	-0.663437	0.266751	-0.197493	0.195233
IC	-0.616673	0.258012	-0.301936	0.266758
IND	-0.300316	0.362177	0.063294	0.134385
END	-0.486775	0.146210	-0.193917	0.280450
ED	-0.504584	0.240336	-0.131279	0.320084
UEW	-0.555330	0.222356	0.079548	0.115948
IOD	-0.590247	0.183654	-0.210285	0.248509
EMD	-0.432813	0.231066	-0.005956	0.121656
CRL	-0.442166	0.148942	-0.077083	0.480182
STR	-0.505437	0.003349	0.193505	0.423794
ETD	-0.434091	0.013256	-0.042666	-0.029089
TD	-0.454801	-0.073999	0.019507	0.392068
TH	-0.410029	-0.003286	-0.001828	0.299565
IPD	-0.695860	0.270763	-0.209685	0.098802
FAR	-0.560171	0.341887	-0.199770	0.340841
UAR	-0.439892	0.281102	-0.145970	0.273143
ICTW	-0.359371	0.217068	0.016269	0.122003
ICTL	-0.258713	0.049751	-0.304584	0.023081
HAL	-0.483817	0.272694	-0.099567	-0.038364
AGD	-0.413116	0.305553	-0.021569	0.207940
THL	-0.561172	0.158227	-0.261686	0.167739
TBL	-0.430912	0.321156	-0.202575	0.308753
TAL	-0.503087	0.384316	-0.231488	0.265735

species group. *Bufo crucifer* would occupy the first and second sub-units. LYNCH (1979) joins these two regions together to count the number of endemic species, showing that it would be very similar. *Bufo pombali* sp.nov. would occupy the fifth sub-unit, and *B. ornatus* would occupy the fourth sub-unit. *Bufo abei* sp.nov. would occupy the sixth sub-unit, and *B. henseli* would occupy the seventh sub-unit, delimited to the north by the Serra Geral, that crosses the State of Rio Grande do Sul separating it from the State of Santa Catarina. These mountains reach the Atlantic coast bordering the distribution of *B. henseli* to the south.

DUELLMAN (1999) defined the *B. crucifer* species group as a monotypic group, for the Atlantic Rain Forest and Pampas. Considering the examined

material and bibliography, we observed that species of this group are also distributed on the borders of the Brazilian Cerrado.

Specimens of *B. abei* sp.nov. and *B. henseli* were collected in the region of the Itaimbezinho Canyon, Municipality of Cambará do Sul, State of Rio Grande do Sul. This could be a possible contact area between these two species, but it is possible that the specimens of *B. henseli* were collected at the top of the canyon and the specimens of *B. abei* sp.nov. in the plain (Paulo C.A.Garcia, pers. comm.). The average height of the canyon wall in that area is of approximately 800m. This observation seems to reinforce the model proposed by LYNCH (1979).

Morphometric analysis – The morphometric analysis was used to test if the morphometric

Table 9. Loadings: Pearson's coefficients correlation (r) for the 25 significant measurement variables in the canonical analysis.

CHARACTERS	VECTOR 1	VECTOR 2	VECTOR 3	VECTOR 4
SVL	-0.80 *	0.25 *	0.23 *	0.17 *
HL	-0.78 *	0.13 *	-0.22 *	0.24 *
HW	-0.85 *	0.23 *	-0.15 *	0.14 *
IC	-0.82 *	0.23 *	-0.24 *	0.20 *
IND	-0.50 *	0.41 *	0.06	0.13 *
END	-0.72 *	0.15 *	-0.17 *	0.24 *
ED	-0.73 *	0.24 *	-0.11	0.27 *
UEW	-0.78 *	0.21 *	0.07	0.10
IOD	-0.81 *	0.17 *	-0.17 *	0.19 *
EMD	-0.67 *	0.24 *	-0.00	0.11
CRL	-0.67 *	0.15 *	-0.07	0.43 *
STR	-0.74 *	0.01	0.17 *	0.36 *
ETD	-0.69 *	0.01	-0.04	-0.02
TD	-0.69 *	-0.07	0.02	0.35 *
TH	-0.65 *	-0.00 *	-0.00	0.28 *
IPD	-0.87 *	0.23 *	-0.15 *	0.07
FAR	-0.77 *	0.32 *	-0.16 *	0.27 *
UAR	-0.67 *	0.29 *	-0.13 *	0.24 *
ICTW	-0.59 *	0.24 *	0.02	0.12
ICTL	-0.45 *	0.06	-0.32 *	0.02
HAL	-0.72 *	0.27	-0.09	-0.03 *
AGD	-0.64 *	0.32	-0.02	0.19 *
THL	-0.79 *	0.15	-0.22 *	0.14 *
TBL	-0.66 *	0.33	-0.18 *	0.27 *
TAL	-0.72 *	0.37	-0.20 *	0.22 *

(*) significant $P < 0.05$.

external variables would corroborate taxonomic groups. Most of the variation observed in the first two canonical vectors could be explained by the size component, mainly because almost all coefficients have the same signal (Tab. 8), denoting that their scores increase in the same direction in both axes (HUMPHRIES *et al.*, 1981). However, variables DT and AT should contain a "shape" component for the second vector, explaining their variation.

The projection of the scores (Fig.27) shows that the specimens of *B. crucifer* and *B. pombali* sp.nov. are well discriminated in a general way. The species *B. henseli* was discriminated satisfactorily, with few individual scores overlapping the cloud of points of *B. ornatus* and *B. abei* sp.nov., perhaps caused

by the influence of the size variables, as the analysis of canonical variables is not corrected for these parameters.

Bufo ornatus and *B. abei* sp.nov. demonstrate a high degree of overlap among their scores. It is interesting to observe that, although there is an almost total superposition of the scores in the canonical analysis, the polygon of *B. abei* sp.nov. is confined to a certain area within the polygon of *B. ornatus* (Fig.27), demonstrating that the analyzed population of *B. abei* sp.nov. has a differential component for size compared to *B. ornatus*. Although they are very close species, *B. abei* sp.nov. can be easily distinguished from *B. ornatus* morphologically and their geographical distribution is adjacent, but distinct. The existence of contact

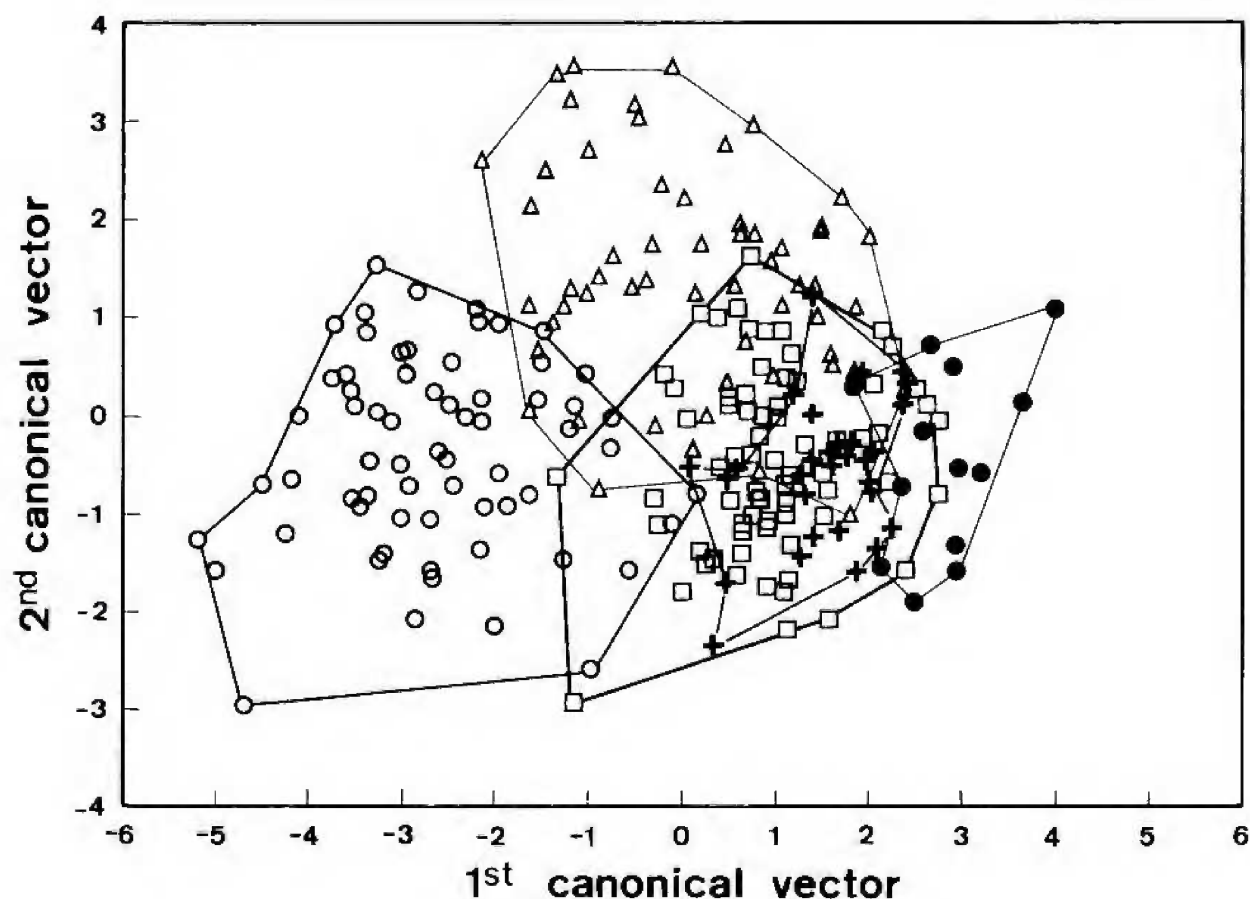


Fig.27- Projection of the individual scores of the combined samples of *Bufo crucifer* (O), *B. ornatus* (□), *B. henseli* (●), *B. abei* sp.nov. (+), and *B. pombali* sp.nov. (△), in the reduced space of canonical variables 1 and 2.

areas and the production of hybrids between these two forms cannot be dismissed, especially because the formation of hybrids among species in the genus *Bufo* is quite common (HADDAD, CASTANHO & CARDOSO, 1990). If hybrids are indeed formed, the analysis of gene fragments would help to corroborate this idea or verify whether there is gene flow between these populations and evidence of genetic introgression.

SPECIMENS EXAMINED

Bufo crucifer – BRAZIL: CEARÁ: Serra do Baturité (MNRJ 13585, 21898). PARAÍBA: Areia (MNRJ 18076-18078; CFBH 2924); Pirauá (MZUSP 59378). PERNAMBUCO: Caruarú (AL-MN 1570-1574); Igarassú (CFBH 2489); Recife (CFBH 2912-2915; MNRJ 3016, 3043; MZUSP 50059); Tapera (AL-MN 2773). SERGIPE: Areia Branca (MZUSP 37821-37822). BAHIA: Campo Formoso (MZUSP 38806); Cruz das Almas (MZUSP 4983); Cumuruxatiba (MZUSP 59422-59432); Ilhéus

(CFBH 2582-2583, 2909-2917; MNRJ 1360, 1497, 1696, 1708, 1709, 1710, 1718, 2593, 2881, 7496-7498, 21899, 21900-21905, 21906-21907); Itabuna (MNRJ 21924-21926); Itajibá (JJ 6208-6214); Maracás (MNRJ 21921-21923; JJ 6215-6233); Nova Canaã (EI 2986); Nova Viçosa (MNRJ 22327-22328); Prado (MNRJ 21927); Salvador (MZUSP 8192-8197, 8341, 9150-9154, 9333-9339, 9532-9541, 10771-10778, 49884); Valença (MNRJ 21908-21918, 21919-21920). ESPÍRITO SANTO: Aracruz (CFBH 2834, 2863-2867; MNRJ 17774, 18454-18456); Baixo Guandú (MNRJ 21929-21930; MZUSP 35617-35619, 35656-35671); Bananal (MNRJ 344, 358); Barra Seca (MNRJ 1758, 1938); Cachoeiro do Itapemirim (MNRJ 3863); Conceição da Barra (MNRJ 20900-20901, 22313-22316); Domingos Martins (MNRJ 18458); Goitacazes (MNRJ 1523); Itá (MZUSP 27377); Linhares (CFBH 958-959); Mutum (MNRJ 352, 353, 5337-5343); Rio Itaúna (MZUSP 4967-4969); Santa Luzia (MNRJ 3157); Santa Teresa (MNRJ 1265, 1285, 1355-1357, 1362, 1497, 1508, 1754, 1944,

21928; MZUSP 27378-27385, 27799-27800, 30531-30539, 50060-50065); Serra de Jacaraípe (MNRJ 21931); Sooretama (MZUSP 4017, 27386-27388); Vila Velha (CFBH 2874-2877); Vitória (AL-MN 2759-2762).

Bufo ornatus – BRAZIL: RIO DE JANEIRO: Angra dos Reis (CHUNB 0224-0262, 14275-14279; MNRJ 345, 1392; MZUSP 7980-7987); Araruama (MNRJ 21999-22000); Bangú (MNRJ 2449); Barra do Pirai (MNRJ 2517); Bom Jesus de Itabapoana (MZUSP 59931); Cachoeiras de Macacú (MNRJ 22047-22048); Cambuci (EI 2983-2984); Duque de Caxias, Serra do Barro Branco (AL-MN 2956-2963; MNRJ 1581, 1764, 1813, 2471, 2733, 21993-21998); Engenheiro Paulo de Frontin (MNRJ 21672, 21680-21685, 22319); Gondotiba (MNRJ 2767); Ilha Grande (MNRJ 21932-21958); Ilha da Marambaia (MNRJ 19383); Itaguaí (CFBH 2868-2871; EI 2985; JJ 6235-6241); Itatiaia (MNRJ 349, 2475; MZUSP 4121-4122, 10828, 10830); Macaé (MZUSP 648); Manguinhos (AL-MNRJ 4234, 3353); Maricá (MZUSP 56102); Mendes (MNRJ 1989); Miguel Pereira (MNRJ 22342; MZUSP 27390); Niterói (MNRJ 18514-18515, 22005); Nova Friburgo (AL-MN 2796; JJ 6338-6369); Nova Iguaçu, Reserva do Tinguá (EI 4767; MNRJ 22006-22013); Nova Iguaçu, Rio d'Ouro (MNRJ 0361, holotype of *Bufo crucifer* var. *roseana*); Paraíba do Sul (MNRJ 2867); Parati (CFBH 1377; EI 3 sp. without number; MNRJ 22001-22004); Parque Nacional da Serra dos Órgãos (MNRJ 21991-21992); Petrópolis (MNRJ 2733, 21959, 21962, 21964-21975); Quintino Bocaiúva (MNRJ 22049); Ramos (MNRJ 600, 2704, 3052); Resende (MNRJ 22039-22041); Rio Bonito (MNRJ 22050); Rio de Janeiro (AL-MN 92-95, 277-286, 613, 875; 3358, 4203, 4256-4259; EI 262-264, 265-267; MNRJ 0362, holotype of *B. crucifer mayi*; MNRJ 347, 356, 359, 360-361, 600, 1337, 1548, 1613, 1810, 1904, 1911, 2070, 2106, 2126, 2204, 2422, 2429, 2474, 2537, 2608, 2704, 3050, 3052, 3095, 3502, 5344-5346, 22014-22038, 22044-22046, 22312; MZUSP 10864, 20908, 20832-20833, 27389); Santa Maria Madalena, Parque Estadual do Desengano (MNRJ 21821); Silva Jardim, Reserva Biológica Nacional de Poço das Antas (MNRJ 22053); Teresópolis (MNRJ 346, 1990, 2026, 2154, 2456, 3305, 5704-5707, 21976-21979); Três Rios (MNRJ 22052). SÃO PAULO: Ana Dias (MZUSP 27391); Apiaí (JJ 6268); Bananal (MNRJ 22209); Barueri (MZUSP 20593-20594, 22553, 22549); Bauru (MNRJ 22208); Bertioja (JJ 6242-6267; MZUSP 22622, 50076-50092); Boracéia (EI 268-269; MZUSP 4161-4162, 4588-

4592, 9928-9929, 10510-10514, 27397-27398, 27399-27404, 27405, 27407-27416, 27814, 28779-28781, 28782, 28783, 28784-28789, 30523, 30549, 37725-37726, 37768, 54424-54425); Botucatu (JJ 6062-6198, 6407; MZUSP 7898, 10883, 13848-13849, 16147-16148, 27393-27395); Botujurú (MZUSP 27392); Caieiras (MZUSP 27396); Caminho do Mar (MZUSP 10141-10142); Campinas (MZUSP 36859-36860); Campo Grande da Serra (MZUSP 687); Campos de Jordão (MNRJ 1946); Capão Bonito (CFBH 1689); Caraguatatuba (MZUSP 27488-27495, 27497-27500, 27502-27506, 27508-27515, 27517-27519, 27521-27523, 27525-27538, 27540, 27542-27546, 27548-27551, 27553-27564, 27566-27568, 27569-27570, 27571, 27572-27579, 30546, 36766-36780); Cubatão (MZUSP 492); Eldorado Paulista (MNRJ 22163); Embú (MZUSP 27444-27453); Engenheiro Ferraz (MZUSP 27422-27440); Engenheiro Marsillac (MZUSP 27418-27421); Ferraz de Vasconcelos (MZUSP 3688-3690, 3692-3693); Franca (MZUSP 755); Funil (MZUSP 527); Garça (SJRP 0666); Guarujá (MZUSP 37328); Guarulhos (MZUSP 27441, MNRJ 1964, 1972, 2147, 2879); Iguape (MZUSP 27487, 27581-27585, 27586-27590, 60020); Ilhabela (MZUSP 688, 714, 745, 22794, 6383, 6407, 8775-8777, 8806-8810, 9968, 27793-27796, 27797-27798, 50066-50069); Iporanga (MZUSP 23877-23878, 23879-23882); Itaberá (MZUSP 13477); Itanhaém (CHUNB 14280; JJ 6406; MZUSP 734, 9671-9673, 30485, 30771-30773; SJRP 0671-0673); Itapeceira da Serra (EI 6374; MZUSP 27442-27443, 27444-27445); Itapevi (EI 2987, 4764); Itú (MZUSP 27454-27455, 30524); Jacupiranga (JJ 6405); Jundiaí (CFBH 725-727); Juquiá (MNRJ 2875); Limeira (MZUSP 9639-9640); Nova Louzã (MZUSP 27457-27458); Paranapiacaba (MNRJ 22202; MZUSP 241, 726, 748, 8833-8835, 10116, 10141-10142, 10635-10639, 10641-10647, 10963-10966, 10993-10998, 30521); Pardinho (JJ 6199-6207); Peruíbe (MZUSP 27591-27618, 30631-30652, 57714-57716, 58072-58074); Perus (MZUSP 426); Piedade (MZUSP 2282-2283); Piquete (MZUSP 206, 378, 676-677); Piraju (JJ 6370-6392; MNRJ 19422, 22203-22207); Praia Grande (MZUSP 27660-27699, 27619-27659, 27700-27714, 22531-22545); Rio Claro (CFBH 1373, 2224; CHUNB 14270-14271, 14274; MNRJ 1968, 2142; MZUSP 2007, 29685-29686); Rio Grande (MZUSP 736, 731); Santo André (MZUSP 27470-27471, 27480-27484); Santos (MZUSP 682, 12491-12493, 37328); São Carlos (MNRJ 22162); São João Novo

(MZUSP 27459); São Paulo (AL-MN 2374-2375, 2466-2472; MNRJ 1964, 1972, 2147, 2879, 22159-22161; MZUSP 102, 426, 2657, 2829, 6423, 7775-7785, 7989, 8059-8073, 8772-8773, 9029, 9325, 9378-9385, 9592-9595, 9679, 9790-9796, 10350, 12876-12905, 12665-12677, 12679-12690, 9992-9994, 9996-10003, 10582-10583, 22452-22459, 27460, 27468-27469, 27472, 27473-27478, 27485, 56588; SJRP 0670; ZUEC 0295, 0440); São Sebastião (JJ 6312-6337; MNRJ 16702; MZUSP 717, 27535, 22793; SJRP 0667-0669, 2493, 2671); São Vicente (MZUSP 345, 389-390); Serra do Mar (MNRJ 22168-22201); Serra Negra (MZUSP 27461); Ubatuba (CFBH 326-329, 1056, 1206-1220, 1225, 1683, 1710, 1748-1759, 1774, 1813, 2920-2923; JJ 6393-6398; MZUSP 27736-27740, 28887, 28443-28446; ZUEC 0265, 4360); Vista Alegre do Alto (MZUSP 27486); Vitoriana (MZUSP 12919). ARGENTINA: CORRIENTES (MACN 3506). MISIONES: Candelaria (MACN 36578); Parque Nacional Iguazú (MACN 32782).

Bufo henseli – BRAZIL: SANTA CATARINA: Capinzal (MCP 2308); Nova Teutônia (MZUSP 8646-8664); Rancho Queimado (P.C.A. Garcia field number 321). RIO GRANDE DO SUL: Camaquã (MCN 2531); Cambará do Sul, Itaimbezinho (MCN 1036, 1894); Caxias do Sul (MCP 1615); Cerro Largo (MZUSP 27810); Porto Alegre (AL-MN 452, JJ 6296-6306; MCN 0449); Santa Maria (ZUFMS 0196, 0206, 0347, 0494-0495); São Francisco de Paula (MCP 0371; MCN 7498); Viamão (MCN 1194).

Bufo abei sp.nov. – BRAZIL: PARANÁ: Açungui (MZUSP 15768-15769, 23872-23876); Antonina (MNRJ 1788); Caiobá (MZUSP 15770-15773, 23868-23871); Guaraqueçaba (MNRJ 22243-22246); Guaratuba (CFBH 2929-2931; MZUSP 15778-15779, 27808); João Eugênio (MZUSP 27806); Marumbi (MZUSP 54497); Morretes (CFBH 2836-2840; ZUEC 4728); Quatro Barras (CFBH 2818); Reserva Florestal de Santa Cruz (MZUSP 15774-15777, 27801-27805); Rio do Meio (MZUSP 27807); Serra de Araraquara (MNRJ 1795). SANTA CATARINA: Blumenau (CFBH 2857-2858); Bombinhas (MCP 1643-1644); Camboriú (JJ 6311; MCP 1756); Colônia Hansa (MZUSP 465, 785); Corupá (MZUSP 27809); Florianópolis, Canasvieiras (PCAG 577); Florianópolis, Córrego Grande (MCP 3118-3119; MNRJ 24963, 24964-24967; PCAG 458); Harmonia (MZUSP 689); Itapoá (CFBH 2841); Novo Horizonte, Lauro Müller (MZUSP 35332-35349, 53774-53808); Pirabeiraba (MZUSP 55846-55850); Humboldt (MNRJ 348); Joinville (MNRJ 1559, 1567, 2130, 2282, 3059); Porto Belo (MNRJ

without number); Rio dos Cedros (CFBH 2842-2844; EI 4759-4763; JJ 6234; MZUSP 58651); Santa Luzia (MNRJ 3157). RIO GRANDE DO SUL: Cambará do Sul, Itaimbezinho (MCN 3027).

Bufo pombali sp.nov. – BRAZIL: MINAS GERAIS: Além Paraíba (MNRJ 22232); Alfenas (FETA 11-22, 33, 44); Belo Horizonte (CHUNB 14272-14273; JJ 6399-6304; MZUSP 10972); Caeté (MZUSP 23883-23888, 23890-23893, 23895-23897, 23899-23901, 23903, 23905, 23907-23924, 23926-23929, 23930-23935, 23937-23938, 23940-23943, 23945); Cambuquira (MNRJ 22230); Caparaó Velho (MZUSP 57921); Caratinga (MNRJ 22231); Conceição de Ibitipoca (MNRJ 22229); Conceição do Mato Dentro (MZUSP 57278); Estação Agrícola do Pomba (MNRJ 22236-22239); Grão Mogol (MNRJ 22234-22235); Juiz de Fora (AL-MN 2480-2481, 2540-2543; MNRJ 18496-18502, 22210-22218); Manhuaçu (MNRJ 22240-22242); Mariana (MZUSP 702-703); Marliéria (JJ 6410-6412; MNRJ 22233); Parque Nacional do Caparaó (MZUSP 57920); Poços de Caldas (MNRJ 22220-22224); Presidente Soares (MNRJ 22225-22226); Riacho da Cruz (MZUSP-P 27376); Sabará (MZUSP 27374-27375); São Geraldo (MNRJ 22227-22228); São Gonçalo do Rio Abaixo (MNRJ 21466-21477, 22219, 22291-22294, 22296-22311, 22320-22326); São João Nepomuceno (MNRJ 22042-22043, 22329-22330); Simonésia (MNRJ 22317-22318); Simplicio (MZUSP 27479); Varginha (MNRJ 3322); Viçosa (JJ 6307-6310; MNRJ 662; MZUSP 50072-50075).

ACKNOWLEDGEMENTS

We thank Guarino R. Colli (CHUNB), Oswaldo L. Peixoto (UFRRJ), Jorge Jim (UNESP), Marcos Di Bernardo (MCP), Paulo E. Vanzolini (MZUSP), Luiz Dino Vizotto (SJRP), Ivan Sazima (ZUEC), Sonia Cechin (ZUFMS), Antonio J.S. Argôlo (Universidade Estadual de Santa Cruz, Ilhéus, BA), Cristina Arzabe (Universidade Federal da Paraíba, João Pessoa, PB), Luciano M. Castanho (Pontifícia Universidade Católica, Sorocaba, SP), Paulo C.A. Garcia (Universidade de Mogi das Cruzes, SP), Frederico Gruber, and Edinilza Maranhão, for making their collections available or providing specimens. Anne d'Heursel (Universidade Estadual Paulista, Campus de Rio Claro, SP), José P. Pombal Jr. (MNRJ), Leandro R. Monteiro (Universidade Estadual do Norte Fluminense, Campos, RJ), Márcio Martins (Universidade de São Paulo, SP), and Ronaldo Fernandes (MNRJ) for helpful comments on earlier drafts of the manuscript.

Jaime Somera for the line drawings. F.A.Baldissera Jr. thanks CNPq and CAPES for the grants. U.Caramaschi thanks CNPq and FAPERJ, and C.F.B.Haddad thanks FUNDUNESP, CNPq, and FAPESP for financial supports.

LITERATURE CITED

- AB'SÁBER, A.N., 1977. Os domínios morfoclimáticos na América do Sul. Primeira aproximação. **Geomorfologia**, São Paulo, **52**:1-22, 1 map.
- BALDISSEIRA JR., F.A.; BATISTIC, R.F. & HADDAD, C.F.B., 1999. Cytotaxonomic considerations with the description of two new NOR locations for South American toads, genus *Bufo* (Anura: Bufonidae). **Amphibia-Reptilia**, Leiden, **20**:413-420.
- BLAIR, W.F., 1972. **Evolution in the Genus Bufo**. Austin & London: University of Texas Press. 459p.
- BOETTGER, O., 1885a. Liste von Reptilien und Batrachiern aus Paraguay. **Zeitschrift für Naturwiss**, Halle, **58**:213-248.
- BOETTGER, O., 1885b. Berichtigung der Liste von Reptilien und Amphibien am Paraguay. **Zeitschrift für Naturwiss**, Halle, **58**:436-437.
- BOKERMANN, W.C.A., 1966. **Lista Anotada das Localidades-Tipo de Anfíbios Brasileiros**. São Paulo: Serviço de Documentação, Reitoria da Universidade de São Paulo. 183p.
- BOULENGER, G.A., 1882. **Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum**. 2.ed. London: British Museum. 503p.
- BOULENGER, G.A., 1886. A synopsis of the reptiles and batrachians of the Province Rio Grande do Sul, Brazil. **Annals and Magazines of Natural History**, London, **5**(18):423-445.
- CAVALCANTI, M.J. & LOPES, P.R.D., 1993. Análise morfométrica multivariada de cinco espécies de Serranidae (Teleostei, Perciformes). **Acta Biologica Leopoldensia**, São Leopoldo, **15**(1):53-64.
- CEI, J.M., 1980. Amphibians of Argentina. **Monitore Zoologico Italiano (NS) Monograph**, Firenze, **2**:1-609.
- COCHRAN, D.M., 1955 - Frogs of Southeastern Brazil. **United States National Museum Bulletin**, Washington, **206**:1-423.
- COPE, E.D., 1862. Catalogues of the reptiles obtained during the explorations of the Parana, Paraguay, Vermejo, and Uruguay Rivers by Capt. Thos. J. Page, U.S.N., and of those procured by Lieut. N. Michler, U.S. Top. Eng., commander of the expedition conducting the survey of the Atrato River. **Proceedings of the Academy of Natural Sciences of Philadelphia**, Philadelphia, **14**:346-359.
- CUVIER, G., 1829. **Le Règne Animal Distribué d'Après son Organisation**. Paris: Déterville, Crochard. v.2. xv, 406p.
- DUELLMAN, W.E., 1970. The hylid frogs of Middle America. **Monograph of the Museum of Natural History, University of Kansas**, Lawrence, **1**:1-753.
- DUELLMAN, W.E., 1999. **Patterns of Distribution of Amphibians: A Global Perspective**. Baltimore & London: The Johns Hopkins University Press. 633p.
- DUELLMAN, W.E. & SCHULTE, R., 1992. Description of a new species of *Bufo* from Northern Peru with comments on phenetic groups of South American toads (Anura: Bufonidae). **Copeia**, Lawrence, **1992**(1):162-172.
- DUMÉRIL, A.M.C. & BIBRON, G., 1841. **Erpétologie Générale, ou Histoire Naturelle Complète des Reptiles**. Paris: Roret. V. 8. 784p.
- FITZINGER, L.I., 1826. **Neue Classification der Reptilien nach ihren natürlichen Verwandtschaften. Nebst einer Verwandtschafts-tafel und Verzeichnisse der Reptilien-Sammlung des K. K. Zoologischen Museum's zu Wien**. Wien: J.G.Heubner. 66p.
- FITZINGER, L.I., 1843. **Systema Reptilium. Fasciculus Primus. Amblyglossae**. Viena: Braumüller et Seidel. 106p.
- FITZINGER, L.I., 1860. Die ausbeute der österreichischen Naturforscher an Säugethieren und Reptilien während der Weltumsegelung Sr. Majestät Fregatte Novara. **Sitzungsberichte der Akademie der Wissenschaften in Wien. Mathematisch-Naturwissenschaftliche Klasse**, Wien, **42**:383-416.
- FROST, D.R., 1985. **Amphibian Species of the World: A Taxonomic and Geographical Reference**. Lawrence: Allen Press, Inc. & The Association of Systematics Collections. 732p.
- FROST, D.R., 2002. **Amphibian Species of the World: An Online Reference. Version 2.21** (15 July 2002). Available: <<http://research.amnh.org/herpetology/amphibia/index.html>>. Captured on 16 March 2004.
- GARMAN, S., 1884. The North American reptiles and batrachians. A list of the species occurring north of the Isthmus of Tehuantepec, with references. **Bulletin of the Essex Institute**, Essex, **16**:1-46.
- GIRARD, C.F., 1853. Descriptions of new species of reptiles, collected by the U.S. Exploring Expedition, under the command of Capt. Charles Wilkes, U.S.N. Second part. Including the species of batrachians, exotic to North America. **Proceedings of the Academy of Natural Sciences of Philadelphia**, **6**(7):420-424.
- GÜNTHER, A., 1858. **Catalogue of the Batrachia Salientia in the Collection of the British Museum**. London: British Museum. 160p.
- HADDAD, C.F.B.; CARDOSO, A.J. & CASTANHO, L.M., 1990. Hibridação natural entre *Bufo ictericus* e *Bufo crucifer* (Amphibia: Anura). **Revista Brasileira de Biologia**, Rio de Janeiro, **50**(2):739-744.
- HADDAD, C.F.B. & SAZIMA, I., 1992. Anfíbios anuros da Serra do Japi. In: MORELLATO, L.P.C. (Org.) - **História Natural da Serra do Japi: Ecologia e Preservação de uma Área Florestal no Sudeste do Brasil**. Campinas: Editora da UNICAMP. p.188-211.
- HEYER, W.R., 1984. Variation, systematics, and zoogeography of *Eleutherodactylus guentheri* and closely related species (Amphibia: Anura: Leptodactylidae). **Smithsonian Contributions to Zoology**, Washington, **402**:1-42.
- HEYER, W.R.; RAND, A.S.; CRUZ, C.A.G.; PEIXOTO, O.L. & NELSON, C.E., 1990. Frogs of Boracéia. **Arquivos de Zoologia**, São Paulo, **31**(4):231-410.

- HOOGMOED, M.S. & GRUBER, V., 1983. Spix and Wagler type specimens of reptiles and amphibians in the Natural History Museum in Munich (Germany) and Leiden (The Netherlands). **Spixiana**, Leiden, **9**:319-415.
- HUMPHRIES, J.M.; BOOKSTEIN, F.L.; CHERNOFF, B.; SMITH, G.R.; ELDER, R.L. & POSS, S.G., 1981. Multivariate discrimination by shape in relation to size. **Systematic Zoology**, Washington, **30**(3):291-308.
- ICZN - International Commission on Zoological Nomenclature, 1999. **International Code of Zoological Nomenclature**: adopted by the International Union of Biological Science. 4.ed. London: The International Trust for Zoological Nomenclature. xxix, 306p.
- JIM, J., 1980. **Aspectos ecológicos dos anfíbios registrados na região de Botucatu, São Paulo (Amphibia, Anura)**. São Paulo. 332p. Tese (Doutorado em Zoologia), Instituto de Biociências, Universidade de São Paulo.
- KLOSS, G.R., 1972. **Os Rhabdias dos Bufo do grupo marinus: um estudo de espécies crípticas (Nematoda, Rhabditoidea)**. São Paulo. 90p. Tese (Doutorado em Zoologia), Instituto de Biociências, Universidade de São Paulo.
- LAURENTI, J.N., 1768. **Specimen Medicum, Exhibens Synopsin Reptilium Emendatum cum Experimentis Circa Venena et Antidota Reptilium Austriacorum**. Viena: Typ. Joan Thom. Nob. De Trattner. 214p.
- LUTZ, A., 1934. Notas sobre espécies brasileiras do gênero *Bufo*. **Memórias do Instituto Oswaldo Cruz**, Rio de Janeiro, **28**(1):111-133.
- LYNCH, J.D., 1979. The amphibians of the lowland tropical forests. In: DUELLMAN, W.E. (Ed.) **The South American Herpetofauna: Its Origin, Evolution, and Dispersal**. Lawrence: University of Kansas Museum of Natural History. 189-215p. (Monograph 7).
- MARTIN, R.F., 1972. Evidence from osteology. P.37-70 In: BLAIR, W.F. (Ed.) **Evolution in the Genus Bufo**. Austin & London: University of Texas Press.
- McDIARMID, R.W., 1994. Preparing amphibians as scientific specimens. In: HEYER, R.W.; DONNELLY, M.A.; McDIARMID, R.W.; HAYEK L.A.C & FOSTER, M.S. (Eds.) **Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians**. Washington: Smithsonian Institution Press. 289-297p.
- MIRANDA-RIBEIRO, A., 1926. Notas para servirem ao estudo dos gymnobatrachios (Anura) brasileiros. **Archivos do Museu Nacional do Rio de Janeiro**, Rio de Janeiro, **27**:1-227, 22 pls.
- MIRANDA-RIBEIRO, A., 1937. Alguns batrachios novos das colleções do Museu Nacional. **O Campo**, Rio de Janeiro (Maio):66-69.
- MÜLLER, P., 1973. **Dispersal Centers of Terrestrial Vertebrates in the Neotropical Realm**. The Hague: Junk Publishers. 244p. (Biogeographica, n.2).
- MYERS, C.H. & DUELLMAN, W.E., 1982. A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from Western Panama. **American Museum Novitates**, New York, 2752:1-32.
- NIEDEN, F., 1923. **Das Tierreich. Anura I**. Berlin: Preubischen Akademie der Wissensschaften zu Berlin. v.46, xxxii, 584p.
- NORMAN, D.R., 1994. **Anfibios y Reptiles del Chaco Paraguayo. Amphibians and Reptiles of the Paraguayan Chaco**. San José: Edition of Author. 281p. 32pls.
- SAVAGE, J.M. & HEYER, W.R., 1967. Variation and distribution in the tree-frog genus *Phyllomedusa* in Costa Rica, Central America. **Beiträge zur Neotropischen Fauna**, Stuttgart, **5**:111-131.
- SCHINZ, H.R., 1822. **Das Tierreich eingetheilt nach dem Bau der Thiere als Grundlage ihrer Naturgeschichte und der vergleichenden Anatomie von dem Herrn Ritter von Cuvier**. Stuttgart und Tübingen: J.G. Cotta. v.2.
- SOKAL, R.R. & ROHLF, F.J., 1995. **Biometry**. 3.ed. San Francisco: W.H.Freeman and Co. 887p.
- SPIX, J.B., 1824 - **Animalia Nova Sive Species Novae Testudinum et Ranarum Quas in Itinere per Brasiliam Annis MDCCCXVII-MCCCXX Jussu et Auspidis Maximiliani Joseph I. Bavarie Regis**. Monachii: S. Hübschmanni.
- STRANECK, R.; OLMEDO, E.V. & CARRIZO, G.R., 1993. **Catalogo de Voces de Anfíbios Argentinos. Parte 1**. Buenos Aires: Ediciones L.O.L.A. 130p.
- WIED-NEUWIED, M.A.P., 1821. **Reise nach Brasilien in den Jahre 1815 bis 1817**. Frankfurt: H.L.Brönnner.